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NASA/ESA CV-990 SPACELAB SIMULATION

FINAL REPORT APPENDIXES

APPENDIX C: DATA-HANDLING SYSTEMS – PLANNING AND IMPLEMENTATION
APPENDIX D: COMMUNICATIONS
APPENDIX E: MISSION DOCUMENTATION

A JOINT ENDEAVOR BY
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
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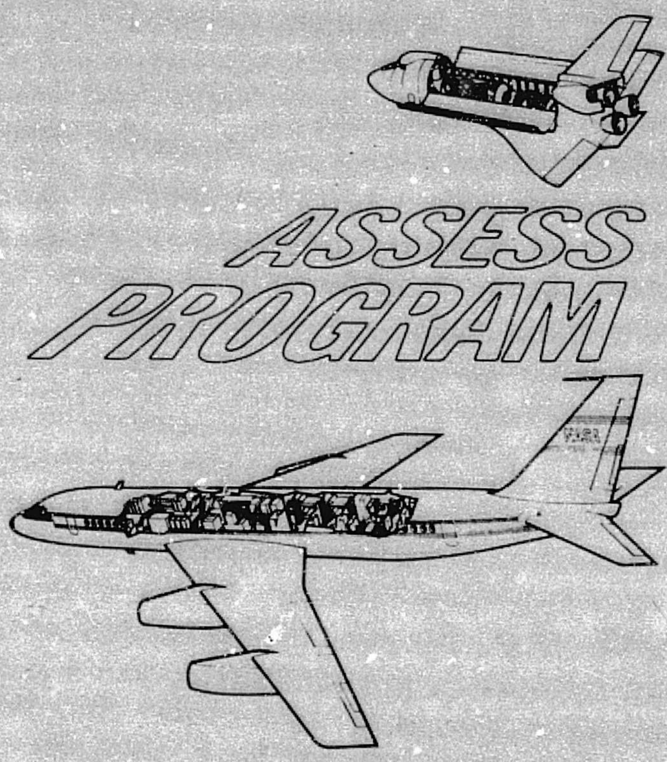

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16. Abstract

As a result of interest in the application of simplified techniques used to conduct airborne science missions at NASA's Ames Research Center, a joint NASA/ESA endeavor was established to conduct an extensive Spacelab simulation using the NASA CV-990 airborne laboratory. The scientific payload was selected to perform studies in upper atmospheric physics and infrared astronomy with principal investigators from France, the Netherlands, England, and several groups from the United States. Two experiment operators from Europe and two from the U.S. were selected to live aboard the aircraft along with a mission manager for a six-day period and operate the experiments in behalf of the principal scientists. Communication links between the "Spacelab" and a ground-based mission operations center were limited consistent with Spacelab plans.

These three appendixes provide detailed information on the data handling, communications, and documentation aspects of the mission. Most experiments provided their own data handling equipment, although some used the airborne computer for backup, and one experiment required real-time computations. Communications facilities were set up to simulate those to be provided between Spacelab and the ground, including a downlink TV system. Mission documentation was kept to a minimum and proved sufficient. Examples are given of the basic documents of the mission.

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FINAL REPORT

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INTRODUCTION

Beginning in the 1980 time period, an advanced space transportation system will be used to conduct experiments in the space environment. This system will consist of a laboratory (Spacelab) carried into orbit by the reusable Space Shuttle. The pressurized Spacelab module provides a shirtsleeve environment in which up to four payload specialists can operate experiments using the basic resources provided by the laboratory. Spacelab is being developed and constructed in Europe under the direction of the European Space Agency (ESA). The Space Shuttle Orbiter is being built by the United States under management of the National Aeronautics and Space Administration (NASA).

THE JOINT MISSION

Similarities between the method of experiment accommodation and operations planned for Spacelab and the methods used in conducting experimentation aboard aircraft by the NASA-Ames Airborne Science Office (ASO) led to the NASA-ESA Joint Mission, the sixth mission in the ASSESS (Airborne Science/Spacelab Experiment System Simulation) program. Six experiments were selected for the mission: three from Europe and three from the United States. The simulation mission took place at the NASA-Ames Research Center, Moffett Field, California, USA, between April 30 and June 24, 1975.

Spacelab payload manpower will be limited to a maximum of four, which means that payload specialists often will be acting as proxy operators for principal investigators' (PIs) experiments. To test the concept of proxy operation, four experiment operators (EOs) were selected and trained on the six experiments.

During the simulation period the EOs performed all experiment operations, including data taking, normal servicing, and minor repairs. During the entire simulation period (6 days) the four EOs and the Mission Manager were confined to the aircraft and an adjacent sleeping area. All communication with ground based mission elements such as principal investigators (PIs) and the Mission Operations Center (MOC) during the simulation period were handled by communication links (audio and video) simulating those planned for Spacelab. Genuine scientific data were taken by all experiments on all flights.

MISSION OBJECTIVES AND GUIDELINES

The overall objective of the Joint ASSESS Mission was to evaluate a simplified management and implementation concept for conducting Spacelab-like experiment operations. The following were subordinate mission objectives:

1. To experience involvement in international cooperative payload activities

2. To evaluate experiment design approaches for Spacelab experiments

3. To determine the impact of operational requirements and procedures on Spacelab design

4. To evaluate payload and mission operations

5. To assess techniques for smooth integration of experiments and equipment

6. To analyze factors affecting selection and training of payload specialists, particularly in proxy experiment operation.

The Joint ASSESS Mission also served to encourage the development of a cadre of potential Spacelab experimenters. The mission did not address physiological or psychological factors.

The mission guidelines were designed to ensure a high degree of realistic simulation given the capabilities of the CV-990 aircraft, ASO practices, and the requirements for Spacelab as stated about one year before the ASSESS mission. The complete guidelines are provided in the Mission Operating Plan (attachments) and are summarized below:

1. Authentic science to be performed

2. Six basic experiments to be operated (three European, three U.S.)

3. Ames ASO practices to be used as starting point for mission planning and execution

4. Participation of PIs in overall mission to be maximized

5. Four EOs (two European, two U.S.) to operate experiments in proxy role (i.e., on behalf of the PIs)

6. Simulation period to cover 5 days with a data flight each 24-hr period (experiments operated by EOs), with EOs and the Mission Manager confined to vehicle and living quarters

7. Unconstrained flights to be conducted for 2 weeks following the simulation period (experiments operated by PIs)

8. All supporting equipment, tools, and spare parts to be carried onboard

9. Spacelab subsystems to be simulated where possible

10. Use of experiment support equipment to be shared

11. Communication to be limited to one video downlink, two 2-way voice links.

MISSION MANAGEMENT

Basic guidance for the mission was provided by the seven-member Mission Planning Group (MPG), which comprised representatives from both NASA and ESA Headquarters organizations and from the Marshall, Johnson, and Ames NASA centers. The ASO Mission Manager was an ex-officio member of this group. Six planning sessions were held between May 1974 and May 1975 at which the MPG set the schedule, ratified the selection of experiments and EOs, developed the mission guidelines, and checked the status of the mission at all critical points.

The Mission Manager, from the ASO, was the single point of contact for all negotiations, decisions, and assistance in carrying out the mission from inception to completion. With the aid of one full-time assistant, he implemented the directives of the MPG; communicated with the PIs relative to their mission responsibilities; and handled all detailed planning of experiment integration, flight operations, and support activities.

MISSION REPORTS

Mission preparations, operations, and results are documented in an executive summary (ref. 1), a final mission report (ref. 2), and five appendixes. Information for these documents was gathered from several sources: the records of a team of observers who flew on all flights and observed mission activities in detail, mission operational records, mission planning documentation, information prepared by the PIs and EOs, an extensive debriefing following the simulation period, and individual interviews with mission participants.

Of the five appendixes to the mission report, two (A, The Experiment Operator; and B, Experiment Development) are relatively lengthy and occupy separate volumes of their own. The briefer appendixes C, D, and E are presented in this volume.

Appendix C provides the details of the data-handling techniques and procedures employed during the entire ASSESS mission. These included early coordination between the PIs and the ASO; automatically recorded data channels; the use of the Airborne Digital Data Acquisition System (ADDAS); and data-handling systems provided by the PIs. Overall performance of the data-handling systems is discussed, and the use of ground computational facilities is briefly described.

Appendix D addresses the subject of communications during the simulation period. The special facilities set up during the simulation period are described, and details of their usage are given.

Appendix E covers mission documentation. The documents generated during the entire mission are described to show the minimum-documentation approach of the Airborne Science Office. Several important mission documents are included in their entirety.

APPENDIX C

DATA-HANDLING – PLANNING AND IMPLEMENTATION

PREMISSION COORDINATION OF DATA-HANDLING SYSTEMS WITH THE ASO

Experiment selection and approval for the NASA/ESA Joint Mission was completed by September 1974, as shown in the brief chronology of pertinent events in table C-1. Discussions between the PIs and the ASO for utilizing the ADDAS and signals from aircraft systems began in October 1974. The discussions contained another element, new to ASO operations — namely, the use of the Ames computer center for quick-turnaround data processing and stripping of data from ADDAS magnetic tapes. The latter had been performed before, but not on a quick-turnaround basis. The ASO requested that all PI arrangements for the use of ADDAS and aircraft systems be settled by early April, about a month before installation activities commenced at Ames. This deadline was met in most important details. Some uncertainty concerning the quick-turnaround data processing remained until the very start of the simulation period on June 2, because the PI desiring this service had to rewrite his computer program to make it acceptable to the Ames computer's complier.

With one exception, the PIs' requirements for use of the ADDAS and signals from aircraft systems were eventually satisfied; the initial request from JPL for a very high data rate could not be accommodated. Use of the Ames computer center facilities (see p. 25) was considerably more complex and confused than had been anticipated. Parts of the operation were not straightened out until mid-June, after the simulation period of the mission and well into the PI section of the flight schedule.

EXPERIMENT DATA CHANNELS

Table C-2 shows the channels of information that were automatically recorded during the NASA/ESA Joint Mission. All except the photographic channels were recorded on magnetic tape or stripchart. The primary channels carried the basic physical information, which was to be interpreted in terms of atmospheric or astronomical theories. The secondary channels carried information that aided in interpretation or quantified the primary data. In two cases (QMC and NM photometer), the primary channel also carried, sequentially, operations data as well. Each experiment listed in table C-2 had only one sensing device except Colorado, where the grating spectrometer contained two photomultiplier detectors placed appropriately so that one intercepted light in the visible part and the other in the ultraviolet part of the spectrum. Note that only five channels were recorded by more than one device as a caution against losing data.

TABLE C-1.- NASA/ESA ASSESS I MISSION CHRONOLOGY

Date	Event
May 1, 1974	ESA Experiments Approved by Mission Planning Group (MPG)
Sept. 1974	NASA Experiments Approved by MPG
Nov. 22, 1974	US and European Investigators Meeting, Paris
January 1975	Investigators Submit ADDAS Software Requirements
March 21 to April 23	Experiment Readiness Reviews
April 4	ADDAS Arrangements Completed
April 30	Experiment Installation Begins
May 15	Installation Completed
May 21	First Flight for Experiment Checkout
June 2	Simulation Period Begins
June 11	Postsimulation Flight Period Begins
June 20	Last Flight of NASA/ESA Mission

TABLE C-2.- DATA CHANNELS RECORDED DURING THE JOINT MISSION

Experiment	Primary		Secondary	
	Continuous	Sequential	Continuous	Sequential
Queen Mary College (QMC)		1 sky calibrate	3 thermocouples 1 mirror position	
University of Southampton (SH)				
IR TV		1 integrate-readout		
Photometer	1 sky brightness			
IR camera		1 expose delay		
University of New Mexico (NM)				
Photometer		1 8 successive filters		
35-mm camera		1 expose delay		1 fire pulse
16-mm camera		1 expose delay		
Meudon Observatory/ University of Groningen		1* 4 successive filters	8 roll, video and system voltages	1 8 start conditions
Ames Research Center	1* spectral intensity		1* filter position	
University of Colorado	2 spectral intensity			1 4 start conditions
Jet Propulsion Laboratory (JPL)				
UV TAOF	1 spectral intensity		1 sweep voltage	
VIS TAOF	1 spectral intensity		1 sweep voltage	
University of Alaska	1+ spectral intensity			1+ 3 start conditions

*Backup record to GFE 14-channel analog recorder (CP 100) in addition to this channel.

+Backup record to ADDAS, in addition to this channel.

All other experiment-peculiar information required for the interpretation of the primary data (gain settings, time constants, frequencies, etc.) was hand logged by the EOs and PIs. The ADDAS printout provided flight parameters, many of which can be intimately involved in data interpretation. A fairly important correction to IR astronomical data is based on the amount of water vapor in the optical path. The ASO did not have the instrumentation to provide this information, but arranged to borrow an IR radiometer for the NASA/ESA flights. It was planned that water-vapor concentration above the aircraft would be read out on the ADDAS lineprinter in real time. However, owing to complexities of the data-reduction process, the appropriate software could not be generated in time for the mission and the PI from whom the radiometer was borrowed used his home laboratory computing facilities (following the mission) to provide water-vapor information in a form usable to the NASA/ESA PIs. Other readouts on the ADDAS printout were directly usable by the PIs.

Only one PI (JPL) planned complete reliance on the ADDAS for data recording. The Alaska team also had to rely completely on the ADDAS during the simulation period because their own tape recorder had malfunctioned during a checkout flight; after the simulation period, however, they again used the ADDAS as a backup. The ADDAS did provide the only record of QMC data, but this experiment contained a backup digital magnetic tape system in case of a catastrophic ADDAS malfunction. ADDAS malfunctions did occur, but none were considered serious enough to activate the backup system. All other use of the ADDAS and the GFE recorder as recording systems was for backup of experiment systems and for recording housekeeping signals from aircraft flight systems.

Prior to the NASA/ESA ASSESS I mission, the most complex computations carried out by the ADDAS on recent ASO missions had been the solution of individual linear equations, and occasionally an equation involving trigonometric functions. The Fourier transform, obtaining electromagnetic wave intensities as a function of the frequencies involved from the prime data record of intensity as a function of time, involves solving an integral equation. The ADDAS did not have the capacity to handle the full range of observations at the resolution desired by the QMC PI. The PI had two options for the real-time computations: to obtain the complete spectrum at very low resolution, or to compute only a short section of the spectrum but at relatively high resolution (either requiring about the same number of operations by the ADDAS). The PI chose the second option.

The Fourier transform program was not fully debugged until flight 7 (the third of the simulation period). The program and ADDAS worked well on flight 8, but ADDAS could not be brought up at all at the beginning of flight 9 if the inserted program included the Fourier transform subroutine (the reason remained unknown). Thus, no real-time Fourier transforms were performed on QMC interferograms during flight 9. The program worked satisfactorily on all subsequent flights, but during the simulation period, when the real-time transforms were required as hardcopy for PI data evaluation, they were computed on only two flights.

THE CENTRAL DATA SYSTEM
(ADDAS)

Figure C-1 is a block diagram of the ADDAS hardware configuration, consisting of two processors (computers) and peripheral equipment. The data processor is used mainly for data logging, while the executive processor, which is equipped with a disc memory system, does real-time data processing as well as performing most of the other system functions (e.g., managing peripherals). Data from experiments enter the system in either analog or digital form: high-speed analog data through one of two A/D converters, and low-speed analog data of high accuracy through a cross-bar scanner DVM; and digital data through the input/output channels of the data processor. The total throughput of the system is limited to 5000 16-bit words per second by the capacity of the two alternately loaded input buffers. This includes all housekeeping and flight status information, as well as experiment data.

Both the data and executive processors can do real-time processing of experiment data, although the former is largely occupied with the data-logging function. The executive processor runs asynchronously from the data processor but has access through the communications link to the full data stream being logged. This unit runs more complex analyses of data on an experiment-by-experiment basis, with peripheral equipment provided to support a wide variety of applications. For example, it can be used to assemble programs to interact with the data processor and the experimenters' graphics terminal.

The general capabilities of the ADDAS are the formatting, merging, and recording of aircraft status and experiment data on digital magnetic tape; the conversion of up to 42 selected parameters to engineering units for periodic logging on a lineprinter and display on a closed-circuit TV system; the logging in real time of verbal comments via a typewriter terminal; the generation of up to six command signals for output to experiments; and the offline processing of ADDAS or other compatible tapes for quick-turnaround results from experiments. Further details of this system are given in the 1976 Supplement to the Experimenters' Handbook and in NASA TM X-62,367, Interactive Data Management Systems for Airborne Research.

At the time of the Joint Mission, the ADDAS had been in use for about one year on successive airborne missions. The continuous demand for mission-specific software during this period served to delay the completion of the basic software system for the facility and the full verification of hardware performance. As a result, the capability to accommodate digital input from experiments was limited, the output of command signals to experiments was not implemented, and the online performance was less reliable than expected. It should be noted that the QMC real-time Fourier transforms on this mission were the first use of the executive processor for significant data reduction from an experiment.

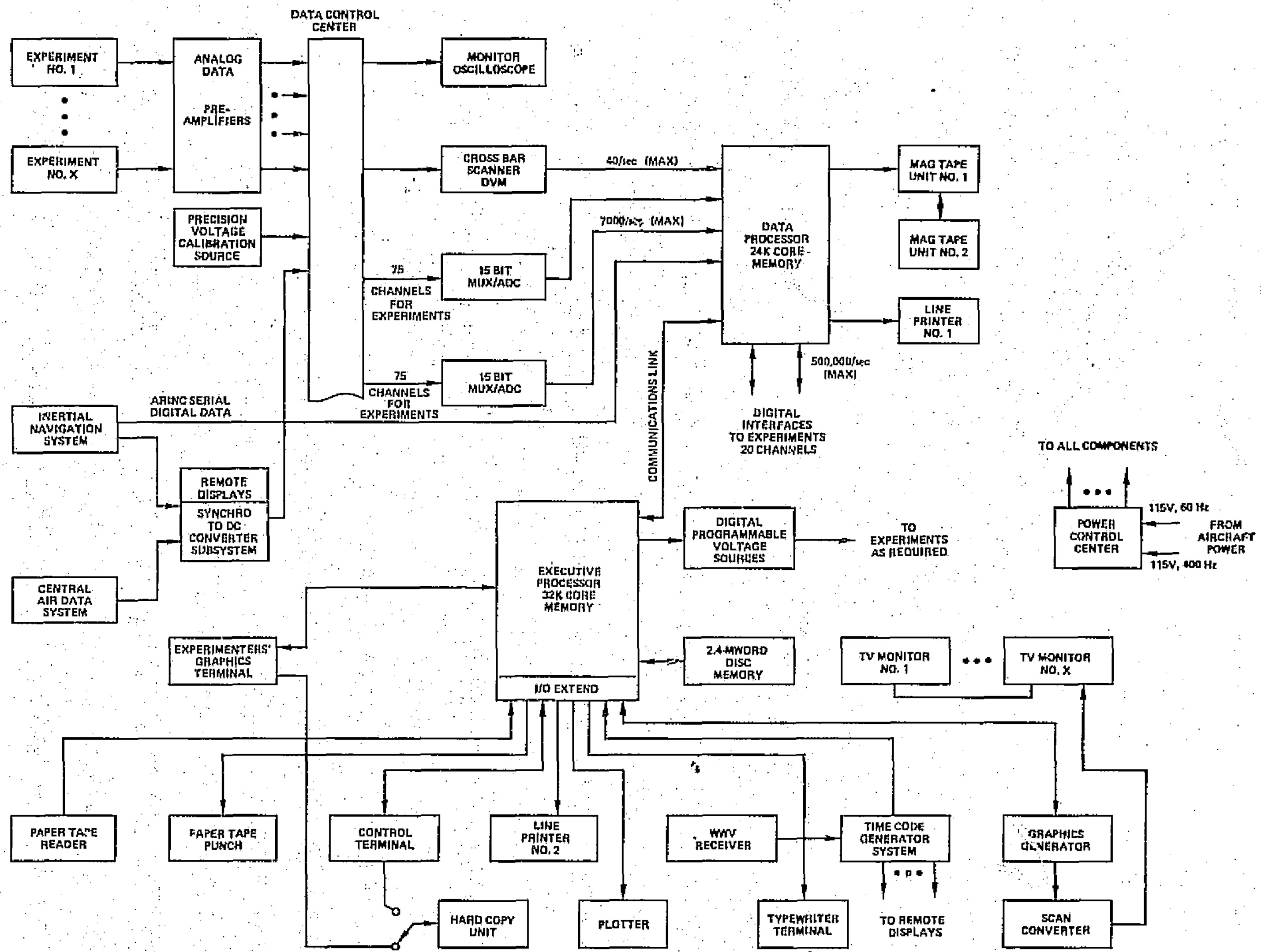


Figure C-1.- Hardware configuration of the Galileo II data system (ADDAS).

ADDAS UTILIZATION

The major effort of checking out signals going into the ADDAS took place on May 14 and 15, about a week before the first check flight. Only the JPL experiment caused the ADDAS program to "hang up": This happened each time the experiment operator threw a switch to put test/ID information on the ADDAS recording. The cause was discovered to be a transient switching spike, and it was eliminated simply by bypassing the switch with a capacitor.

The Alaska experiment had trouble getting the ADDAS to accept their digital output. By May 21 (first check flight), their analog signals were being accepted, but then the Alaska digital tape recorder developed problems and a switch back to digital format was made.

Digital Data Inputs to ADDAS

Inputting digital data to ADDAS is a nonstandard feature that requires special programming to accommodate. This constraint reflects the buffer-limited total throughput of the system as now configured, and the careful allotment of capacity necessary to satisfy all experimenter and housekeeping demands. However, the advantages of handling digital data are leading more experimenters to digitize their data immediately after detection and appropriate amplification, so the capabilities of the ADDAS will probably move toward receiving digital data more readily. Digitization is especially appropriate in systems receiving light levels low enough to allow the counting of the individual photons impinging on the detector. During the Joint Mission, JPL, Alaska, and Colorado employed photon-counting electronics. Meudon/Groningen, QMC and ARC might have utilized the photon-counting approach as well, but chose to work in terms of time-average intensities.

Table C-3 shows the PI requests for digital inputs to and outputs from the ADDAS, and the inputs that were actually made. The signals from QMC had the highest priority and these were satisfactorily connected about one week before flights commenced. When the Alaska experiment was first connected the ADDAS, as noted, would not accept its digital data. As the experiment had low priority on the ADDAS operator's schedule, Alaska was forced to convert to an analog input during the flight checkout period. Then the Alaska digital tape recorder malfunctioned, and the ADDAS became their prime data recorder for the simulation period. The digital input problems of Alaska were located in the ADDAS software and resolved (errors in the ADDAS software were not completely resolved until June 1, the day before the start of the simulation).

The demands of the JPL experiment on ADDAS digital-data capabilities were considerably greater than those of QMC and Alaska, in fact so great that they could not be met at all. Data rates were excessive when considered part of the total ADDAS load, and the lack of personnel time for the development of the appropriate software was a limiting factor. The PI was aware of the situation by January 1975 and therefore was prepared to submit analog signals. Even analog format resulted in some data degradation because 500/sec is the

TABLE C-3.- DIGITAL DATA INPUTS TO ADDAS

Experiment	PI requested usage	Actual usage	Comments
Alaska	40 16-bit digital words/second*	Analog during checkout flights; digital for simulation period.	ADDAS would not accept signals initially. When ADDAS became prime recorder, software problems resolved.
JPL	2 channels 500 16-bit digital words/second	Convert 4 channels to analog	Rate too high for overall ADDAS load
	2 channels 100 16-bit digital words/second	No command pulses to or from ADDAS	Software inadequate for rate at time of mission
	End-of-sweep pulse and sum pulse to ADDAS	No sum by ADDAS Record only	
	Sum-complete/start-sweep command pulse to experiment from ADDAS		
QMC	35 (max) 16-bit digital words/second	As requested	Highest priority digital input to ADDAS

*Original request was for 2000-word/second rate, with data storage at 40 w/s at the experiment and periodic dumps to ADDAS. Negotiations resulted in direct recording at the lower rate.

maximum ADDAS sampling capability. Sending analog to ADDAS caused further data degradation because, according to the PI, at his relatively low signal levels the dual conversion of D/A and then A/D loses about an order of magnitude in accuracy — that is, if D_1 is accurate to 10^{-3} the D_2 is accurate only to 10^{-2}.

Analog Data Inputs to ADDAS and the Central Recorder

Table C-4 summarizes the analog signals sent to the ADDAS and the 14-channel central recorder. The QMC experimenters were apparently unaware that the millivolt signals generated by thermocouples in their equipment were an order of magnitude smaller than the ADDAS system noise.* Another member of their team brought the appropriate d.c. amplifiers, but because of the press of other activities, these were not incorporated into the experiment until after the simulation period (flight 10). The thermocouples were used to record outside window temperature, inside window temperature, and the temperature of the liquid N_2 reference body, for eventual introduction of small corrections to the data. The latter temperature (not used during the simulation period) could be determined from a knowledge of cabin pressure, which was being recorded by ADDAS. The first two could probably be estimated with sufficient accuracy from the values measured during flights 10 to 16 and a knowledge of static air temperature, which was also being recorded by ADDAS. For these reasons, the PI gave the thermocouple record relatively low priority. Although not an analog signal in the true sense, the pulse code modulated signal from Meudon/Groningen is included in table C-4 because it was recorded on analog tape.

Signals to Experiments from ADDAS and Housekeeping Center

All PIs rely in one way or another on flight parameters such as time, latitude, longitude, altitude, pitch, and roll for proper interpretation of their data. Easily the most convenient means of incorporating flight parameters is to simultaneously record experiment data and the relevant flight parameters on the same magnetic tape. Then the appropriate computer program allows postflight correlations, corrections, or other manipulation of the primary data to be made automatically. The time code is generated in the housekeeping rack and is available to all experiments. Also components mounted in the housekeeping rack partially decode the INS output to provide aircraft pitch and roll to any experimenter requesting it. The ADDAS fully decodes the INS output and records the derivative parameters as well as those provided by other aircraft systems (e.g., altitude, air temperature, cabin pressure) on magnetic tape. However, there is no provision for ADDAS to supply these parameters from the ADDAS to the individual experiments as electrical signals to be recorded on magnetic tape. Thus, those PIs who elect to utilize the ADDAS for data recording can use computer programs for automatic data manipulation. Otherwise the PIs must record time and then utilize the

*This point is not clearly stated in the CV-990 Experimenter's Handbook.

TABLE C-4.- ANALOG DATA INPUTS TO ADDAS AND 14-CHANNEL CENTRAL RECORDER

Experiment	ADDAS	Central recorder	Comments
QMC	3 thermocouple outputs	---	Signals originally in mV range; not amplified for input to ADDAS until flight 10
SH	---	---	
NM	---	---	
Meudon/Groningen	---	Prime data channel	Pulse code modulated at 1400 pulses/second; recorder bandwidth barely sufficient
		Voice channel	Aircraft intercom channel no. 2
Ames	Prime data channel	Prime data channel	
	Filter position	Filter position	
		Voice channel	From experiment system
JPL	Prime data channels (2)	---	All four channels in use only on flight 10; one channel of each on all other flights
	Sweep-position indicator channels (2)		
Colorado	---	---	
Alaska	---	Prime data channel	These only during flights 5 through 9 as backup to ADDAS
		Start sweep pulse	
	Prime data channel		These only during flights 1 through 3; then switch to digital signals for ADDAS input
	Start sweep pulse		
		Heliostat elevation and azimuth	
Ancillary system (NOAA)	2 data channels	---	

ADDAS lineprinter readout (which includes all aircraft parameters) to correlate data with flight parameters.

Most PIs elect to correct and analyze their data on their home laboratory computing facilities. In normal ASO missions occasional use is made of ADDAS signals to make corrections in real time by actually controlling some aspect of experiment operation. Although ADDAS was not so used during the Joint Mission, QMC did use a separate roll signal derived directly from the aircraft INS (by PI equipment) to stabilize one axis of their optical path by controlling the orientation of a mirror in their input optics.

As noted in an earlier section, the ADDAS performed real-time Fourier transforms for QMC, as well as computing three experiment-related temperatures and the sequence number assigned by ADDAS (for record keeping) to the interferogram being transformed. In addition, the NOAA radiometer signals were processed to yield numbers proportional to ambient atmospheric water vapor. It was not possible to implement the JPL request (table C-3) for ADDAS to sum data signals and output command pulses to the experiment. The QMC temperatures and NOAA water-vapor data were displayed by ADDAS on its peripheral TV system and printed as hardcopy in real time.

The Joint Mission offered the first opportunity to utilize the ADDAS capability of making hardcopy readouts of computer memories external to itself. Both Meudon/Groningen and Alaska utilized this capability, primarily during the simulation week, to produce hardcopy to be transmitted down to the PI. Meudon/Groningen continued to make occasional use of the facility during the PI flights since these hardcopies provided permanent record information not otherwise available to the PI in real time. Because of its lateness, QMC's request for hardcopy prints of the real-time Fourier transforms received low priority on the ADDAS operator's work schedule; consequently, the connection to the hardcopy unit was never made, and Polaroid pictures of the terminal display were substituted.

Table C-5 summarizes the signals that went from the ADDAS, or aircraft systems via the housekeeping rack, to the experiments and operators. Some of the unimplemented PI requests for signals include parameters that ADDAS was unable to supply (mentioned above); the others were not implemented due to the overall workload on the support personnel at the time.

In addition to the signals listed in table C-5, all stations had visual access to a closed-circuit TV on which all important aircraft parameters were displayed with 10-sec updating, and all PIs eventually got copies of the lineprinter record (basically the same information displayed on the TV). The printer makes five copies, but owing to the general workload during the simulation period only four copies were made available for PI perusal. The additional copies required were printed after the simulation period.

TABLE C-5.- ADDAS AND AIRCRAFT SYSTEMS SIGNALS TO EXPERIMENTS

Experiment	Flight parameters		Computed experiment data		
	Recorded at experiment	Control of experiment	TV display	Line printer	Hardcopy
QMC	---	Roll signal	3 experiment temperatures Interferogram sequence no.	3 experiment temperatures Interferogram sequence no.	Spectra (Polaroid photographs of ADDAS terminal display)
SH	Time code	---			
NM	---	---			
Meudon/ Groningen	Time code, roll signal, pitch signal*	---			IR maps from PI terminal display
Ames	Roll signal	---			
Colorado	---	---			
JPL	---	Start sweep pulse*			
Alaska	Time code (seconds) Time code (minute interval) Latitude* Longitude* Heading* Roll signal* Pitch signal* Pressure* Heliostat elevation Heliostat azimuth	---			Spectra from PI terminal display
Ancillary system (NOAA)	---	---	Water-vapor parameter	Water-vapor parameter	

*Signals requested but not provided.

PI-SUPPLIED EQUIPMENT

Tape and Stripchart Recorders

The recording equipment supplied by the PIs is listed in table C-6. As frequently happens, every experiment employed at least one stripchart (an X-Y plotter in one case) in one capacity or another; six of the eight experiments also used magnetic tape recorders. In two cases — Southampton and New Mexico, both of which recorded internal signals — the stripchart provided the only record of the signal. In most cases important internal signals were recorded also on magnetic tape. When used, the Colorado stripchart recorded data off the prime magnetic tape record. All the PIs who had tape recorders, except QMC, used them to provide their prime data record. The common reason given for local recording was the ease of obtaining the prime data record if it is made on the PI's own recorder.

A recording device conspicuous by its absence during the Joint Mission was the digital printer, which has seen increasing use on normal ASO missions as the use of digital data processing has become more common. During a remote-based mission in 1974, for example, four of the seven different experiments aboard employed such printers for quick-look readouts and permanent records.

Minicomputers

Inexpensive, relatively flexible minicomputers were first observed in use on the CV-990 in 1973. The popularity of the minicomputer — compared to using the ADDAS, for example — is enhanced by the fact that the computer is used in the PI's laboratory for months or years prior to a mission so that the various routines it carries out are thoroughly debugged before installation aboard the aircraft.

Minicomputer usage during the Joint Mission is shown in table C-7. The Meudon/Groningen group was the only one to make full utilization of their software capabilities; both the EO and the PI did so, to roughly the same extent. The real-time analysis capabilities of the Alaska and Colorado software were approximately equivalent because similar analytic operations were required by each: the wavelength scale could be expanded, the positions and relative intensities of spectral features could be read out, etc. However, the EOs were not asked to carry out any of these analytical operations; they definitely didn't have the time in flight. Some analysis might have been worked in between flights, but by then the PIs had the data in hand and could perform their own analysis, albeit manually. After the simulation period, the Alaska and Colorado PIs had considerably more time for real-time analysis in flight than did the EOs. They elected to record only, however; the data they obtained were basically the same that the EOs had been recording for them, and contained few if any new features. These PIs apparently did not use their analysis capabilities on the ground between flights, and they delayed all extended analysis efforts until their return to home laboratories, as did the Meudon/Groningen group, whose minicomputer was incapable of the complex operations required to reduce their data.

TABLE C-6.- PI-SUPPLIED RECORDING EQUIPMENT

Experiment	Tape recorder		Stripchart	Photographic
	Record rank	Type		
QMC	Backup; not used	Dual, digital, cassette	Single channel; prime data channel	
SH				
IR TV	Prime	Integrated video		
IR camera				16-min exposures of total star field
Photometer			Single channel; only record	
NM				
Photometer			One channel of calibrate information; only record	
35-mm camera			One channel, shutter actuation; correlates photometer record	One 1/2-sec exposure per minute
16-mm camera				30 1-sec exposures per minute
Meudon/ Groningen	Prime	Digital, 7" reel	6 channels experiment operations data	
	Reference data	Video, 7" reel	1 channel	
Ames			Two channels; prime data channel and filter position	
Colorado	Prime	Dual, digital, cassette	Single channel (used only to check tape record)	

TABLE C-6.- Concluded.

Experiment	Tape recorder		Stripchart	Photographic
	Record rank	Type		
JPL	Reference information (voice)	Analog cassette	X-Y plotter; one data channel (intermittent use)	
Alaska	Prime (out during flights 4 to 10)	Digital 9" reel	Dual channel; premultiplex and postmultiplex data channel	

TABLE C-7.- MINICOMPUTER USAGE

Experiment	Software capabilities			Actual inflight usage	Comment
	Process/ record	Control	Real-time analysis		
QMC	X	---	---	None	Considered as backup to ADDAS
Meudon/ Groningen	X	X	---	Process/ record/ control	The 16k-core-memory computer controlled telescope scan, and stored IR intensities in memory for subsequent production of IR maps
Colorado	X	X	X	Process/ record/ control	Operation completely remote via computer control Computer summed spectral intensities to enhance signal to noise ratio
Alaska	X	---	X	Process/ record	16k-core-memory computer summed spectral intensities to enhance signal-to-noise ratio

SYSTEMS PERFORMANCE

Experiment Systems

Among the classes of components that make up data-handling systems, demodulators (lock-in or phase-sensitive amplifiers), processors (minicomputers, and one D/A converter and interface box), and recorders (stripchart and magnetic tape) accounted for all systems problems during the Joint Mission. All plain linear amplifiers, A/D converters, multiplexers, and computer terminals operated trouble-free during the mission.

The problems that occurred in the PI-furnished data-handling systems are listed by component type and flight in table C-8. (For a complete listing of problems that occurred during the mission, see appendix B.) All entries in the table represent times when a major data channel was not being recorded by the PI's system, except for the QMC and Ames entries involving stripcharts (both of which presented quick look information which was being recorded elsewhere). These times are accurate where the incident was logged in by the EO or PI; the approximate times are derived from observer notes.

The only data-handling system that seriously malfunctioned due to an internal cause was that belonging to the Alaska group. A drive motor in the tape recorder had a faulty bearing, which introduced erratic tape transport. The electrical fluctuations induced by the erratic motion of the motor somehow fed back into the system's minicomputer, causing it to hang up frequently during the first two check flights. The feedback became worse during flight 3 and finally (after that flight), when a fuse in the motor circuit blew, several transistors in the computer were also ruined. The tape recorder was removed from the aircraft and the faulty motor replaced during the simulation period. The computer was repaired in time for inclusion in the experiment during the simulation period. The data system, with ADDAS acting as prime recorder, operated with minor hang-ups during the simulation week. Thereafter, the system, including the repaired tape recorder, functioned without incident (flights 10 through 16).

If extensive real-time data analysis had been a Colorado requirement, a second potentially serious problem would have arisen. The formatter/terminal display unit in this experiment exhibited abnormal behavior during experiment checkout; it allowed the execution of several simple analytical operations but malfunctioned when other more complex analytical routines were requested. The EOs had no time for even the simpler routines; the PI resolved the problem just prior to the PI flights (loose printed-circuit board), but chose not to utilize the real-time analytical capabilities of the system during that part of the mission. Since the problem never surfaced in flight, it does not appear in table C-8.

Most of the other problems shown involved stripchart recorders (always a troublesome component, but providing a useful readout) and minicomputers. Only the New Mexico stripchart problems caused data loss, however, and it was slight. The other stripcharts were primarily data-monitoring readouts. Of

TABLE C-8.- PROBLEMS IN DATA-HANDLING SYSTEMS

Flight no./ experiment	Time signal not recorded, min	Problem	Action/Comment
Demodulators			
1 SH	None	Phase-sensitive detector erratic	Degraded data throughout flight
14 QMC	~30	Phase-sensitive detector erratic	Found loose reference-signal cable
Processors*	Checkout period		
1 Alaska	≤30	Many short computer hang-ups	During first two hours; cause not determined
2 Alaska	≤15	Many short computer hang-ups	During first hour; cause still not determined
Colorado	33	Computer overheated	Automatic thermal cutout
3 Alaska	144	Computer would not come up	Finally did after disconnecting tape recorder; transients from recorder caused problems on flights 1 and 2
4 Colorado	~20	Computer would not come up	Inexperienced operator; all data lost
	Simulation period		
5 Colorado	~15	Computer would not come up	EO operation begins; all data lost
6 Alaska	~15	Computer would not write on stripchart	D/A converter lacked power; only calibration data lost; repair after flight
Colorado	None	Computer would not write on stripchart	External electrical fault; transfer of magnetic tape data to stripchart; no data lost
7 Colorado	7	Computer would not write on magnetic tape	Reload program; <25% data lost
8 Alaska	~10	Computer would not accept calibration data	End of flight; found open breaker next day
Colorado	7	Computer would not come up	Reload program; <25% data lost
	~33	Computer would not come up	After standby period: all data lost this object; after computer up, could not acquire object
9 No problems reported			

TABLE C-8.- Concluded.

Flight no./ experiment	Time signal not recorded, min	Problem	Action/comment
Processors*			
10 Colorado	13	Computer overheated twice	Automatic thermal cutout
11 & 12 No problems reported			
13 Meudon/ Groningen	48 (PI flights)	Computer stopped, would not come up	Not resolved in flight; <50% data lost
14 Colorado	4	Computer stopped	Power transient; also hung up ADDAS and damaged JPL experiment
JPL	16	Vis TAOF D/A converter and ADDAS interface knocked out	Switch to equivalent unused UV TAOF unit
15 & 16 No problems reported			
Recorders			
1 QMC	~180	Stripchart drive malfunctions	Replaced unit after flight with unit borrowed from another PI
2 Ames	~3	Stripchart stops inking	Coaxed into operation
5 Alaska	5 flights	Faulty magnetic tape transport motor	Repair on ground; reinstall for PI flights
7 New Mexico	~5	Stripchart recorder stops inking	Replenish ink reservoir/ checkout ink system thoroughly on ground
8 New Mexico	~3	Stripchart paper drive fails	Switch to spare
QMC	~130	Stripchart paper drive fails	Off-duty EO attempts repair/ continue work on ground
9 QMC	~105	Stripchart paper drive fails	Try backup NM recorder; it would not advance paper; switch to aircraft roll stripchart after Venus data leg
13 New Mexico	~2	35-mm camera fire-pulse channel malfunctions	Put fire-pulse channel on backup stripchart; repair on ground

*Total experiment-minutes lost ≤410

the minicomputer problems, almost all that were not directly traceable to some physical cause (overheating, power transients, etc.) occurred when an EO or some other person outside the PI's team was operating the experiment (flights 4 and 5 through 9). With the PI as the operator the "computer would not ..."-type problem occurred only once (flight 13).

The problems encountered by the Alaska and Colorado systems on flight 6 and by Alaska again on flight 8 were traceable to electrical failures outside the computer (power supplies on flight 6 and a general circuit breaker open on flight 8). These were remedied on the ground following the flight. The causes for other "computer would not"-type problems were never identified. As indicated in table C-8, these unanalyzed computer hang-ups resulted in considerable data losses.

Overall, the EOs had more difficulties with PI data-handling systems than did the PIs. During the simulation period, the EOs had 2.4 problems per flight. During the checkout flights the PIs had two problems per flight (rather high, but as might be expected at the beginning of the mission), but only 0.8 problem per flight during the final seven PI flights.

Central Computing System

At the time of the Joint Mission, the ADDAS system had been in operation for about one year. During this time, the capability of both the hardware and basic software was improved considerably. Nevertheless, the system went down a total of 30 times during the Joint Mission, 7 of them during the simulation period. Table C-9 shows the frequency and duration of ADDAS malfunctions; in most cases, the source of difficulty was not known. All attempts to correlate ADDAS malfunctions with experiment operational activities failed. As a last resort, problems were attributed to subtle "errors" in the software. The system's initial refusal to do Fourier transforms for QMC was attributed to such an "error" in a portion of the ADDAS program that had run satisfactorily on the preceding flight mission. Indication of additional program subtleties surfaced on flight 9, when it took the ADDAS operator 30 min to get the system up, and he was able to do so only by leaving the Fourier transform routine out of the program. On all subsequent flights, however, the entire ADDAS program, including the Fourier transform subroutine, was utilized.

When ADDAS operations ceased, the operator was usually able to restart the system by means of the controls at his interactive terminal. Quite often, however, the whole program had to be reloaded from digital punched paper tape, a 2 to 3 min operation.

The time and manpower alloted for ADDAS software debugging and checkout against operating experiments (both individually and as an integrated payload) was not adequate for reliable operation of this vital support facility. With two exceptions, JPL and QMC, ADDAS downtime did not cause critical loss of data, since local recording at the experiment was being done. Nevertheless, the uncertain behavior of the system was a deterrent to effective EO operation during the simulation flights and created substantial gaps in aircraft

TABLE C-9.- ADDAS INFLIGHT DOWNTIME

	Flight no.	No. of problems	Downtime, min			Cause/comment
			Data legs*		Nondata leg	
Checkout	1	2	10	Two experiments on line	22	Unknown
	2	2	31			1) Unknown 2) Not writing on tape
	3	1	16			Unknown
	4	2†			10	1) Unknown 2) Make slight program change
Simulation	5	1	20	Three experiments on line		Unknown
	6	2	27			1) Recording, but no computation 2) Unknown
	7	0				
	8	0				
	9	4	29		30	Unknown
PI flights	10	4	58	Two experiments on line		Unknown
	11	2	55			Unknown
	12	1	11			Unknown
	13	2	8		19	Unknown
	14	2			7	1) Unknown 2) Power surge
	15	3	6			All due to rough flight path
	16	2	15			Unknown

*Total experiment-minutes lost = 648.
†One deliberate.

parameter records. Out of a maximum possible 74 hr of observing time during the full 16-flight schedule, the ADDAS was down some 6 hr, or about 8 percent of the time.

GROUND COMPUTATION/DATA STRIPPING

Only QMC undertook any significant data processing between flights at Ames, and only QMC and JPL requested the immediate stripping of at least some of their data from the ADDAS tapes. The former requirement was due in part to the fact that the QMC data were the most abstract collected during the Joint Mission, and they required mathematical transformation before physical interpretation. The early data stripping requested by QMC and JPL was necessitated by the reliance of both groups on the ADDAS for data recording. Early data tape verification on a ground-based tape reader was therefore important, particularly to JPL. The transformations made on QMC data in the Ames computer center revealed that the tape was readable and that the quality of the data on the tape was satisfactory.

A quick-turnaround procedure was devised for immediate postflight processing of ADDAS records of QMC and JPL data. Originals were to be delivered to the Ames computer center about 0400 hr each morning, following the flight debriefing, and processing was to be completed by 0800 hr and results available for PI review. A program was written to strip and record the QMC and JPL data on separate seven-track tapes, and to transform the QMC interferometer records to spectral data printout. With this output, both PIs could evaluate their results in time to plan intelligently for the next flight.

Unfortunately, this postflight data processing plan could not be fully implemented. The ground data-processing needs of QMC and JPL were reasonable enough, but their execution was quite tortuous. The overall data-processing operation for the two groups is summarized in table C-10. To shorten the turnaround time, the ASO departed from standard procedures and allowed the Ames computer center access to the original data tapes instead of duplicates. The time saved found other uses, however; even after debugging, the QMC transformation program still hung up on the idiosyncrasies of the data being recorded. That is, when the two optical paths in a Michelson interferometer (the QMC instrument) are the same length, all waves arriving at the detector arrive in phase, creating a maximum in detected energy. All waves arrive in phase only for this one condition, so the point is unique and the transformation program utilizes this fact. However, the EMI experienced by the QMC experiment provided other maxima in the interferogram as large or larger than the central (equal path length) maximum. Thus, the PI or his representative had to be present during <u>each</u> transformation to specify for the computer which of the recorded maxima were spurious and should be ignored. It took about 1/2 hr per interferogram to study the stripchart and logbook to locate the spurious data, 1/2 hr to derive the associated numerical parameters, and 1/2 hr to punch the appropriate computer program cards before the transformation could begin. Because the spurious data appeared randomly in the interferograms, each had to be treated separately. For all these reasons, less

TABLE C-10.- GROUND COMPUTATION/DATA STRIPPING

Experiment	Desired operations	Actual operations	Comments
QMC	Fourier transform selected interferograms on daily basis for PI review	Approximately as desired after flight 6	Program not debugged until then Spurious spikes in data continued to confuse program PI had to be present to specify central maximum of interferogram
	Strip data from ADDAS tape; record on 7-track tape; at least one by end of flight 9	As desired; first tape after flight 6	Interferograms produced at Ames verified data on ADDAS tape PI wanted to verify at least one tape on home lab reader on his departure from Ames; remainder to follow when task completed
JPL	Strip data from ADDAS tape; record on 7-track tape for daily review	Strip data from first flight tapes, then delay until end of mission	JPL home lab tape reader broke down before first tape could be verified; decided not to waste computation center time until verification. Seven-track tape not verified until PI section of flight schedule
	Copy ADDAS 9-track tapes for daily data review	First tapes not available until after simulation period	Quick turnaround prevented by QMC use of originals. Further delayed by time schedule of simulation period

than a tenth of the interferograms taken during the mission were transformed on the Ames computer.

The stripping of QMC and JPL data from the ADDAS tapes went smoothly enough, but the quick-turnaround time was severely compromised by the unexpectedly complex processing of QMC interferograms from the original records. JPL encountered some difficulties in getting early taped data verification of any kind. As noted in table C-10, the tape reader at JPL malfunctioned before the first stripped tape could be verified there. The JPL PI then requested that the ADDAS operator duplicate some ADDAS tapes (as time allowed) so that he might verify the usability of JPL data on ground-based ASO equipment. Time and manpower limitations precluded this procedure, however, until the PI flights following the simulation period.

CONCLUDING REMARKS

The first Joint NASA/ESA ASSESS Mission demonstrated that a wide variety of data handling requirements must be met by any central facility, and also, that very substantial amounts of time and manpower are required to adapt the central facility to a particular mission. The mission staff must correlate data handling and computation requirements with experimenters well in advance of the mission, taking time to ensure that the experimenters understand the capabilities and limitations of the central facility.

The mission also clearly demonstrated that one of the important functions of the central data handling facility is to provide each experimenter with a detailed, time-coded printout of significant flight parameters. All experimenters on the mission used this information for postflight and postmission correlation of results, not only within their own data base but also to make interexperiment comparisons of similar data.

Experimenters on this mission used the central data facility (ADDAS) primarily as a backup to their own individual data recorders. Only one experiment depended on ADDAS exclusively for recording. One other used it as the prime recorder but also carried a backup system; the latter was never used. This same experiment used the ADDAS to perform complex in-flight data processing in the form of real-time Fourier transforms. A simplified program was developed for this purpose, to match the memory available. If more detailed data processing (e.g., a full 2000-point Fourier transform, as compared with the 300-point transform performed during the Joint Mission) is required in real time in Spacelab, then much greater computing capability will have to be designed into the central data facility (CDMS) than was contained in the ADDAS system.

Several experimenters arranged for postflight data processing in Ames ground facilities, simulating the planned downlinking and processing of data from Spacelab. Unexpected technical and managerial problems were encountered in this activity, and the planned quick-turnaround of data was never fully realized during the relatively short mission period of 5 days.

Three experiments incorporated minicomputers to do internal data processing, to provide operational control, and to display instructions to the human operator. The advantages of such localized, preplanned, and automated operations are expected to accelerate the use of minicomputers and microprocessors. This trend will obviously impact strongly the requirements and plans for the data management on Spacelab. The central facility may be better suited to provide basic housekeeping and flight parameters common to all experiments, to have a reasonable capability for backup recording, a limited capability for real-time processing, and be designed primarily as the collection center for locally preprocessed data to be telemetered to ground stations for detailed reduction and analysis.

In terms of data-minutes lost, the individual data handling systems outperformed the centralized data processing system during the first Joint ASSESS Mission. Downtime on the central system impacted several experiments simultaneously. Since, in addition to cost, basic system reliability will also be a major factor in choosing between using individual or centralized data handling systems in Spacelab, the comparison of the performance of the two approaches to data handling should be continued in any future ASSESS missions.

APPENDIX D

COMMUNICATIONS

COMMUNICATIONS FACILITIES AND GROUND RULES

Facilities provided to simulate communication between Spacelab and the ground are described in "Communications Ground Rules," a memo passed out to all participants in the Joint Mission just before the simulation period. This simulation was of two qualities: Voice and video links were simulated by operating channels, while telemetry and facsimile links were simulated by handcarrying the data involved. The memo is reproduced here (with minor editing) with a sketch of the facilities and locations of equipment (fig. D-1).

Communications Ground Rules

<u>Voice Communication</u>

Two channels of two-way voice communications are available:

<u>Channel 1</u>

From: PI Office Area and PI Conference Room (3 speakers, 3 microphones)

To: Aircraft (3 speakers, 2 microphones)

<u>Channel 2</u>

From: Operations Room (1 speaker, 1 microphone)

To: Aircraft, Mission Manager's Station (1 speaker, 1 microphone)

Channel 2 will be available in the van during sleep periods.

Each voice channel will be operated by actuating the push-to-talk switch on the microphones. Calls can be initiated from either side. All conversations are recorded automatically. Both channels are available for PI/EO consultation; however, channel 1 is the primary mode. Channel 2 has priority as the operational intercom system (Operations Manager/Mission Scientist to Mission Manager).

<u>Telephone</u>

Total of five (5) telephone extensions are available in the Mission Operations Center (MOC) for outside calls.

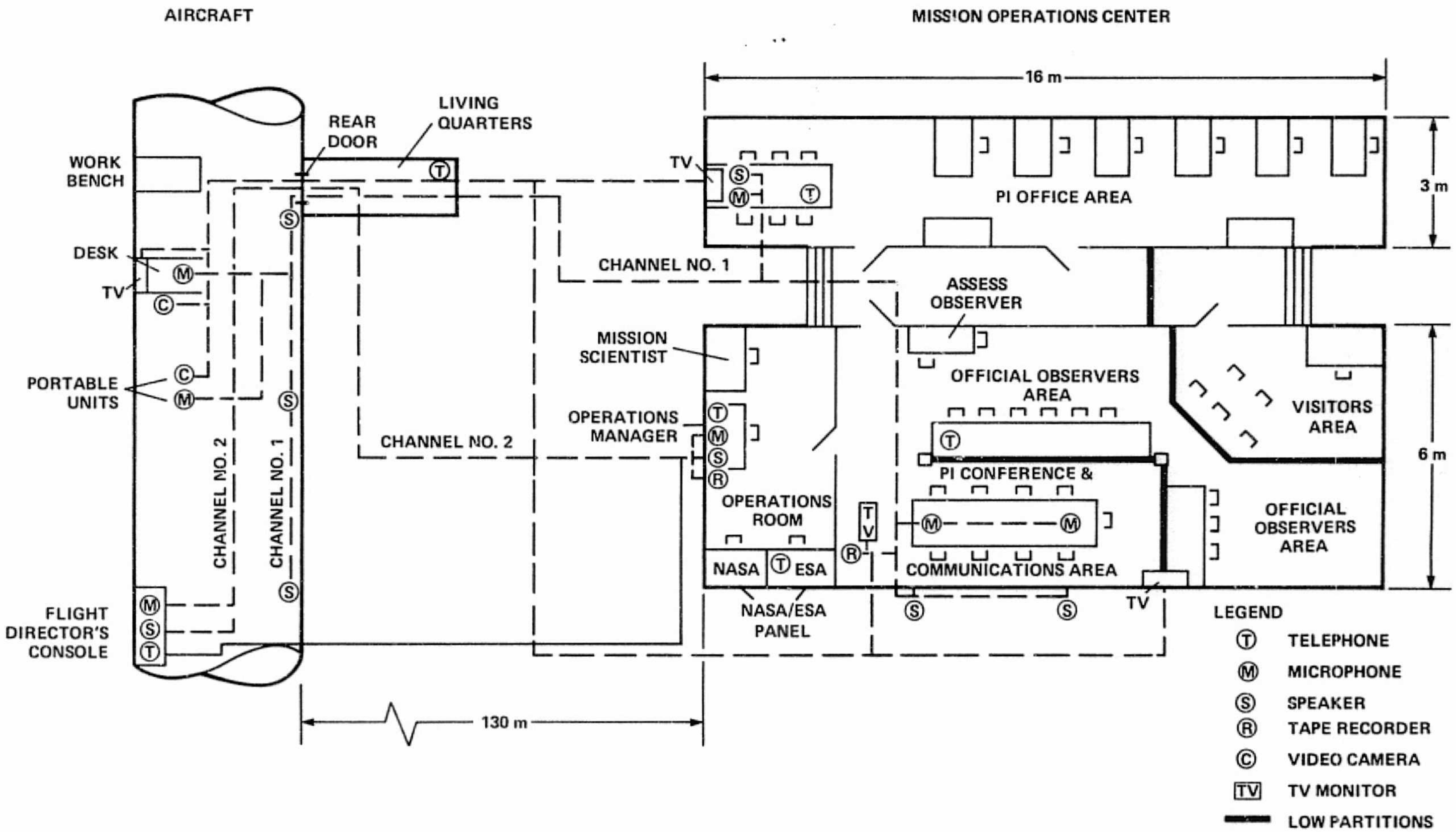


Figure D-1.- Joint Mission communications plan.

An additional extension is available in the aircraft or living quarters. However, this telephone is only for private/emergency calls by confined personnel.

Mission-support related calls by PIs will use an Honor Logging System. A log will be placed by the telephones in the PI trailers and PI Conference Room.

Television

A one-way downlink video communication is provided from the aircraft to the PI Conference Room and PI Office Area. Two (2) cameras are available in the aircraft and operated by an observer on demand by the EOs or PIs. The video downlink shall only be used if necessary. The duration and purpose of each video transmission will be logged by the observer.

"Handcarry" Up- and Downlinks

All data handcarried to and from the aircraft (film, hardcopies, sketches, photographs, etc.) must go through the Operations Manager to be properly logged.

All approved downlink data require logging only.

New requests for downlink data must be approved by the Operations Manager.

All uplink data requires approval by the Operations Manager.

Data Dumps

The Southampton data dump (video transmission) must be logged through the Operations Manager.

FACILITIES UTILIZATION

Voice Communication Channels

Provision was made for tape recording both voice communication channels. The channel-1 recorder, used for almost all PI/EO communication, was controlled by a voice-actuated switch. This switch malfunctioned several times early in the simulation week, but less than 5 percent of PI/EO conversations were lost. Channel-2 conversations were recorded by manually switching on the unit. Through design or oversight, this procedure resulted in some loss of information; it is obvious from the tape that important conversational elements had already taken place when certain records begin. However, the overall loss of information is relatively small since less than 5 percent of all voice communication took place on channel 2.

Voice channel usage may be described in terms of users, subject material, frequency of use, and duration of use. The users included not only the EOs and designated PIs but also most members of the various PI teams at one time or another. If one ignores transmissions where party A seeks party X but talks briefly with Y since X was not available (a fairly frequent occurrence), then all but one transmission was between an EO and the PIs of his prime or secondary experiments.

The PIs and EOs dominated the use of channel 1. The Mission Manager made use of this channel primarily during the preflight meeting and the postflight debriefing (table D-1); otherwise, he was contacted on channel 2. On the other hand, only three short PI/EO exchanges took place on channel 2. Subject material ranged over all aspects of mission and experiment operation, with flight instructions and diagnostic efforts on malfunctioning experiment components being the dominant topics of conversation. Discussion was only occasionally frivolous or beside the point.

Frequency of transmissions was determined on the basis of subject matter: If an EO talked successively with PIs representing, say, three different experiments, this transmission was considered as three different transmissions; if he talked with more than one member of the same PI team, this discussion was counted as one transmission. The overall frequency of transmission, based on the above method of counting, is shown in figure D-2. The simulation period started at 1300 hr on June 2 and ended at 2300 hr on June 7. On the first day of the mission, with fewer hours and no flight experience, there were relatively fewer transmissions. Subsequently, the total number of calls on both channels (excluding preflight and postflight meetings) fluctuated between 35 and 46 per day depending on the situations confronting the EOs.

The duration of channel-1 transmissions was established by using a two-channel tape recorder and recording the WWV time signal on one channel. On channel 2, the person actuating the recorder was requested to log the time at the end of transmission. This task was frequently forgotten, however, and duration of transmission was obtained primarily from a plot of tape recorder reel revolutions vs time.

Figure D-3 summarizes the time spent in voice communication; total duration ranged from 1 to about 3-1/2 hr per day. (Note the difference in ordinate scales.) The calls were frequent, but generally short. The shortest was well under a minute; the longest was 20 min; the average was 4.5 min. Duration of use was low on day 4 of the mission, probably because there had been no flight on the previous day and most problems had been resolved. Use on day 5 was high owing to several new problems that developed during the third flight. In addition, people were getting more accustomed to using the communications system, and transmissions became somewhat more "chatty" in character.

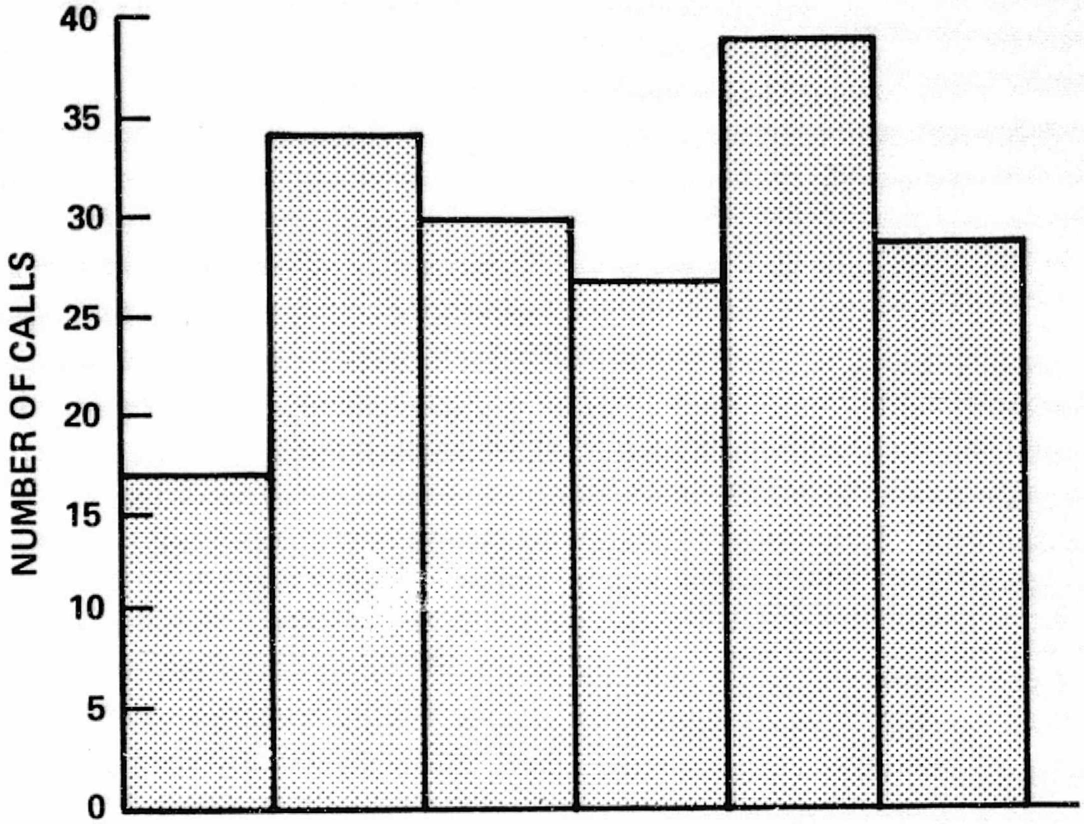
EO use of the voice communication facilities is given in table D-2 and figure D-4. Table D-2 gives the number of transmissions made each day, the total for the simulation period, and the percent of the total that took place between the EO and the PI(s) of his prime experiment(s). Overall, EO

TABLE D-1.- SIMULATION WEEK DAILY SCHEDULE

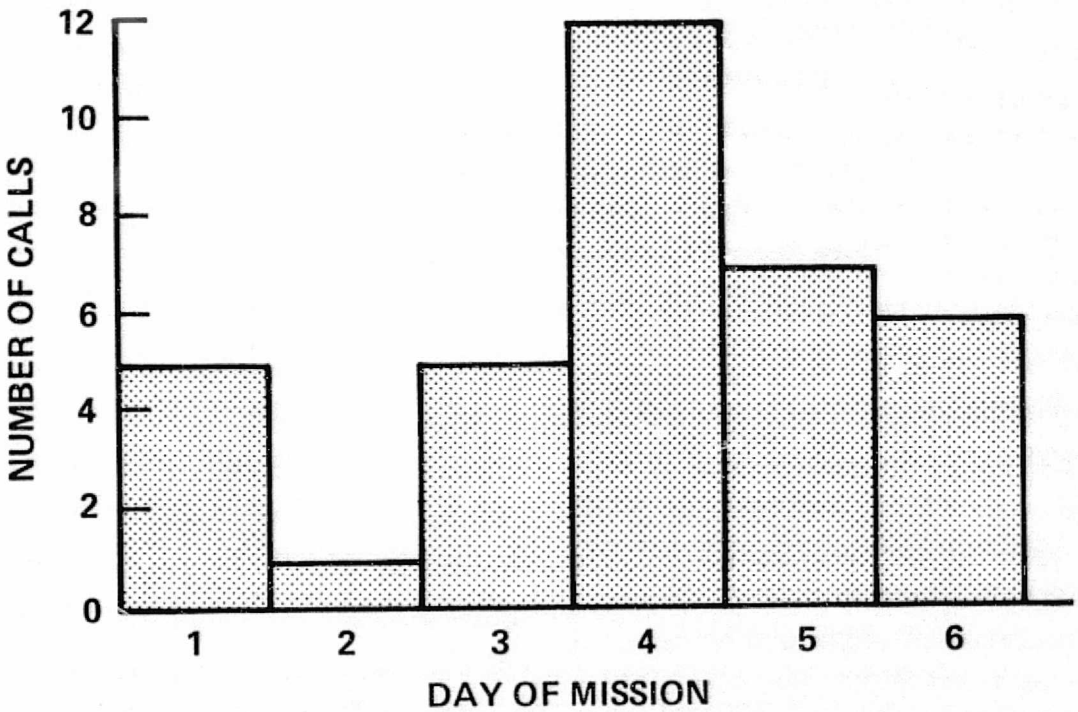
Time (hr)	Events	Location	Participants
L	Refuel aircraft	A/C	MM
L + 1	Lift van attached	A/C	MM
	Communication hookup	A/C	MM, OM
	Cryogenics servicing	A/C	EO
	Data down link	A/C, MOC	EO, MM, PI, OM
	Hand carry		
	• ADDAS tapes to IBM 360		
	• ADDAS hard copy to PI		
	• ADDAS printout to PI		
	• Film to Photolab		
	} Log in through Operations Manager		
	Dump Southampton video record	A/C, MOC	EO, PI
L + 1-1/2	Flight debriefing	A/C, MOC	OM, EO, PI, MM, MS
L + 2	Silence A/C	A/C	EO, MM
	EO meal (optional)	A/C	EO, MM
	Sleep	A/C	EO, MM
	PI-MS consultation	MOC	PI, MS
	Preflight planning		
T - 7-1/2	PI-MS consultation	MOC	PI, MS
	Preflight meeting preparations		
	EO wakeup, shower, breakfast	A/C	EO, MM
T - 6-1/2	EO-PI consultation	A/C, MOC	EO, PI
	Free time		
T - 5-1/2 Approximate time 2PM	Preflight meeting	A/C, MOC	EO, PI, MM, MS, OM
	Formalize final experiment operations		
	Final flight plan		
	Passenger manifest		
T - 4-1/2	Start experiment preparations		
	Film and tape loading	A/C	EO
	Cryogenic loading	A/C	EO
	EO-PI consultation	A/C, MOC	EO, PI
	Meal/free time		
T - 1	Loose-item stowage	A/C	EO, MM
	Passenger boarding	A/C	EO, MM
	Liftvan removed	A/C	OM
	Stop N_2 purge of cavity	A/C	EO, MM
	Communication disconnect	A/C	EO, MM, OM
T - 1/2	Door closure	A/C	EO, MM
T - 0	Takeoff	A/C	EO, MM
	Box lunch available in flight		

NOTE: L + 1-1/2 and T - 5-1/2 meetings were mandatory for all indicated participants - at least one PI per experiment. Operations Manager on duty 24 hr/day.

L: landing
T: takeoff
A/C: aircraft
MOC: Mission Operations Center
PI: Principal Investigator
EO: Experiment Operator
MM: Mission Manager
MS: Mission Scientist
OM: Operations Manager

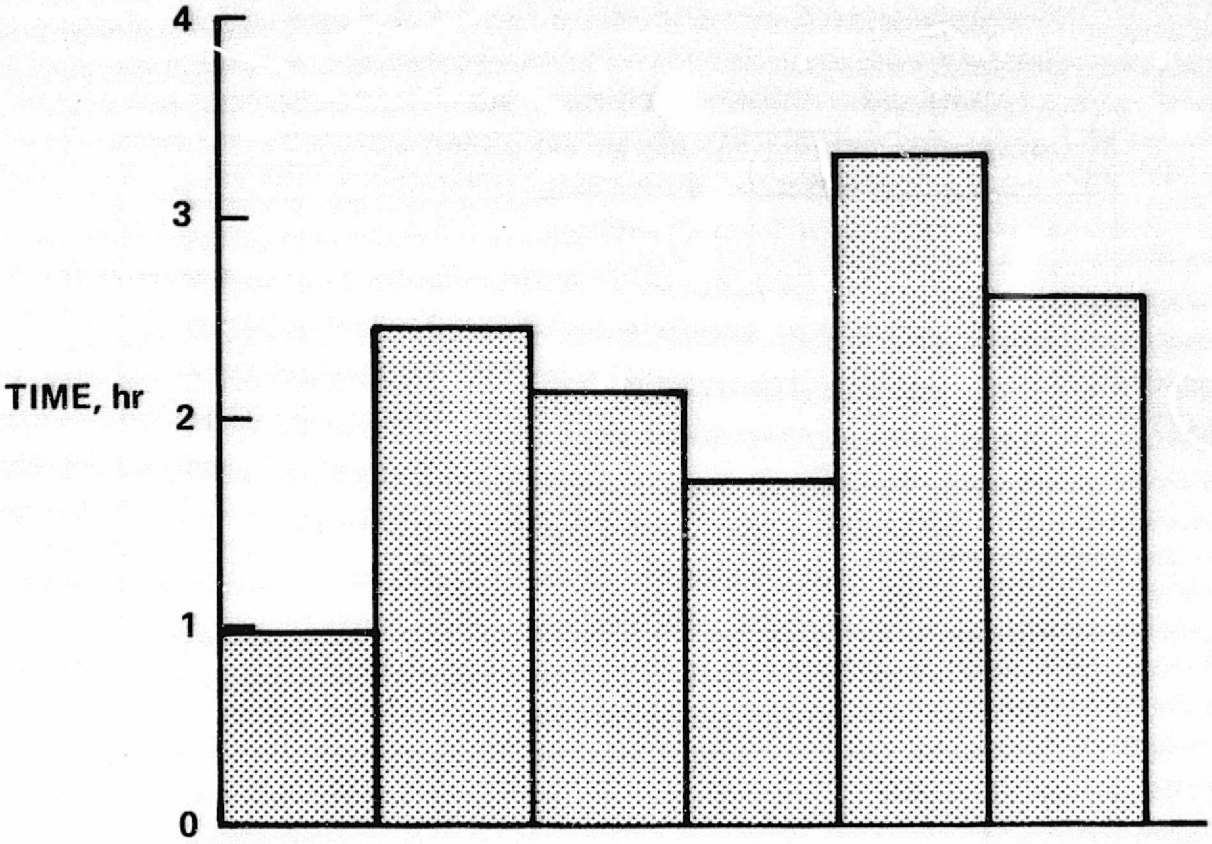


(a) Channel 1.

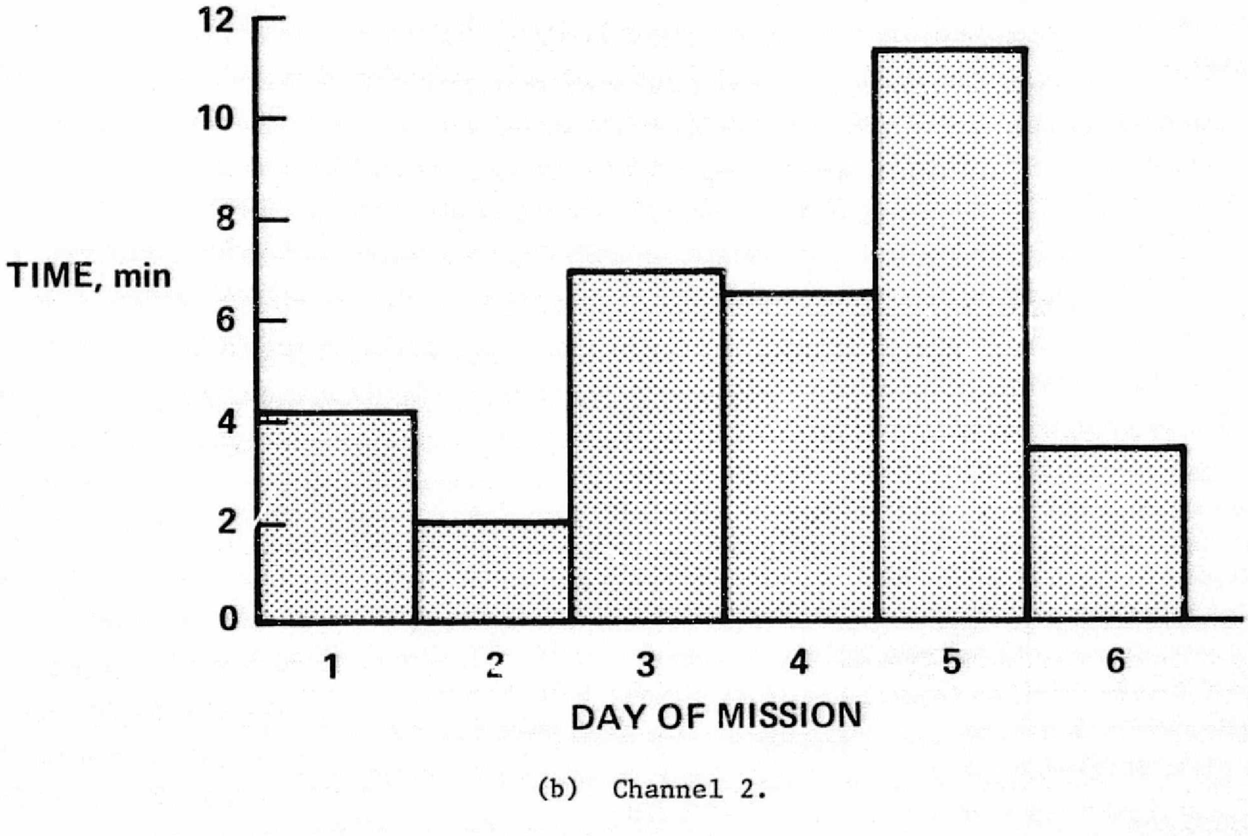


(b) Channel 2.

Figure D-2.- Use of voice communication channels during the simulation period.



(a) Channel 1.



(b) Channel 2.

Figure D-3.- Duration of transmissions on voice channels.

TABLE D-2.- FREQUENCY OF EO/PI VOICE TRANSMISSIONS

Day of mission	No. of transmissions			
	Operator B	Operator A	Operator D	Operator C
1	8	1	0	8
2	11	10	5	8
3	13	8	6	3
4	9	7	5	6
5	11	12	5	11
6	8	9	2	10
Total	60	47	23	46
% to prime PI's	68.5	55.2	47.8	80.5

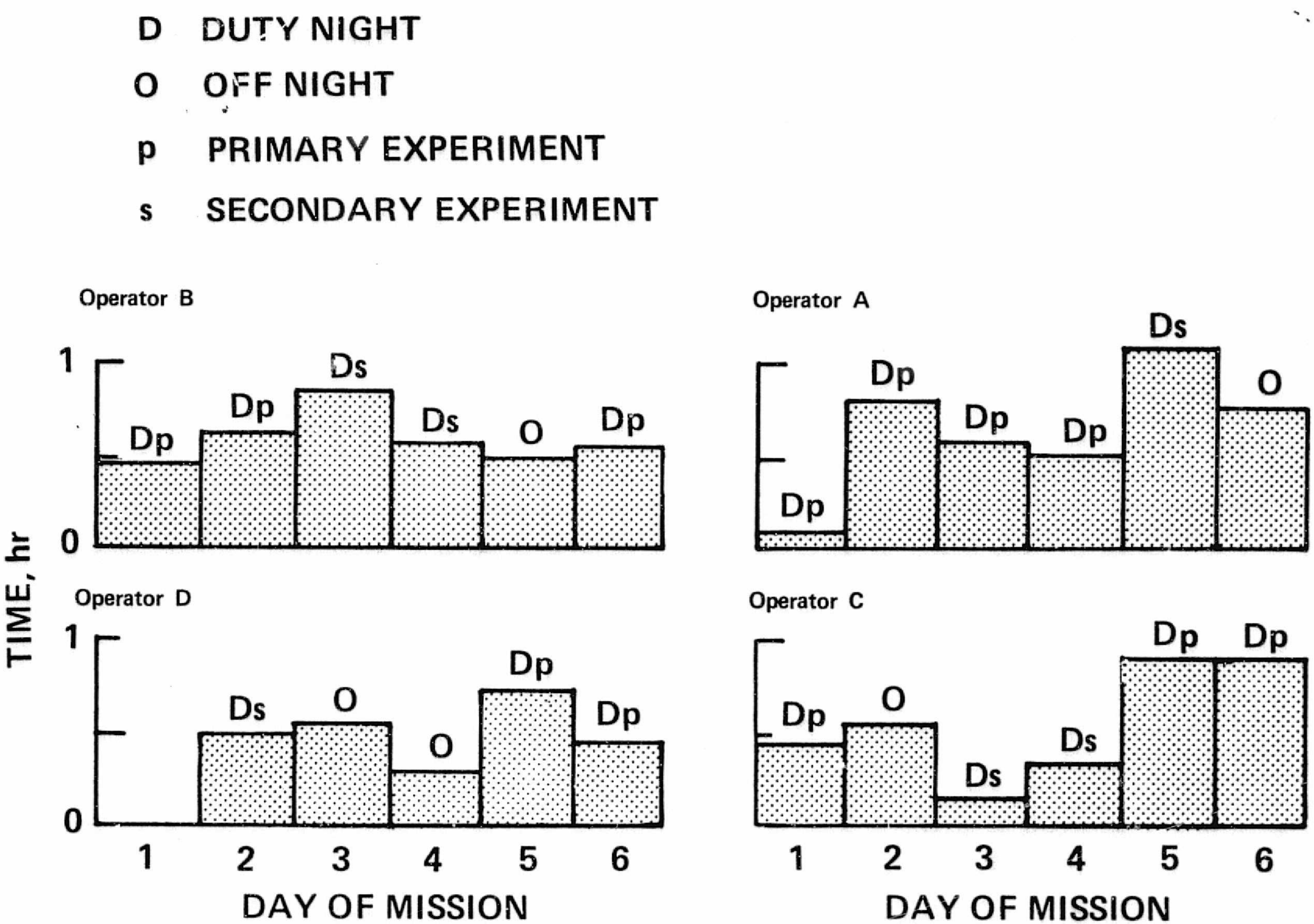


Figure D-4.- Duration of EO/PI transmissions.

transmissions varied from four per day to ten per day, while EO/PI contacts varied from two to seven. Operator D participated in relatively few transmissions — only 23 during the simulation mission compared to 46, 47, and 60 for his colleagues. Further, less than half involved his prime PI. Both facts may be partially explained by the absence of his prime PI at the MOC during much of the period.

Figure D-4 shows the distribution of channel-1 transmission time among the EOs. The figure also shows whether the EO was preparing for a duty night (D) or an off-duty night (O) during the time of the transmissions, and whether the duty was to be on his prime (P) or secondary (S) experiment. Times range from zero to 1.2 hr a day. However, there is no obvious correlation between time spent in discussion with PIs and whether the EO was slated for duty, or whether he was assigned to his primary or secondary experiment. Hours of transmission per day for EOs preparing to operate secondary experiments was only slightly higher than for those preparing to operate primary experiments — 0.7 and 0.6, respectively. (Day 3 is included because the EOs were expecting to fly as designated.) Thus, it was important that the PI be available for consultation before every flight of the simulation period. Even when off duty, the EO had significant matters to discuss.

Overall, the voice communications facilities seemed adequate. They were available for PI/EO exchanges for approximately 32 hr during the total simulation period of 130 hr. Channel 1 was in use about 41 percent of this time and channel 2 (concerning matters of import to the mission) only about 2 percent of the time. The mission was several days along, however, before EOs learned to communicate accurately and effectively with their PIs in problem-solving situations (see Lessons Learned for Spacelab, in ref. 2). For the first few days, individual discussions were somewhat limited to permit all PI teams to conduct vital business in a timely way. As the week progressed and the participants developed their communications skills, the situation improved.

Facsimile Uplink and Telemetry Downlink Simulation

As originally planned, the simulated telemetry downlink was to handle (by handcarrying) only items that could have been telemetered. This constraint would have excluded stripchart records and film, for example. The rule was relaxed because some PIs depended almost entirely on receiving data in such formats for perusal on the ground. The uplink facsimile simulation rules were similarly relaxed, and many items not susceptible to facsimile transmission were handcarried to the aircraft.

The entire log of handcarry and video transmissions is given in tables D-3 and D-4. Table D-3 consists of a transcription of the MOC hardcopy transmittal log; while table D-4 includes the equipment transmittal log (with supplemental information concerning why the transmissions were considered necessary) and a record of the video transmissions made of test or data tapes. MOC personnel logged in the postflight video data dumps but failed to log in those made during the day before flight. Evidence of these preflight video transmissions was

TABLE D-3.- HARDCOPY TRANSMITTAL LOG

Date	Item	Time	No. sheets	No. copies	Up (U) or down (D)
6/2 (Day 1)	Passenger manifest	1505	1	2	U
	Modified operational procedure Alaska experiment	1525	3	1	U
	Flight plan	1550	5	2	U
	Operational procedure JPL experiment	1600	1	1	U
	Flight plan (additional copies)	1700	5	10	U
	Star fields (Meudon)	1735	5	1	U
6/3 (Day 2)	ADDAS data tapes	0610	3	1	D
	ADDAS printout	0620	66	5	D
	Rest of data dump	0750			
	N.M.:				
	Log sheet		1	1	D
	Stripchart		1 roll	1	D
	35-mm film		1 roll	1	D
	16-mm film		1 roll	1	D
	QMC:				
	Log sheets		6	1	D
	Stripchart		1 roll	1	D
	SH:				
	Log sheets		3	1	D
	Stripchart		1 roll	1	D
	35-mm film		1 roll	1	D
	Alaska:				
	Stripchart		1 roll	1	D
	Checklists		2	1	D
	Hardcopy (spectra)		20	1	D
	JPL:				
	X-Y plots		12	1	D
	Colorado:				
	Hardcopy (minicomputer)		1	1	D
	Meudon:				
	Stripchart		1 roll	1	D
	Hardcopy		21	1	D
	General flight log (ADDAS)	0750	5	1	D
	Flight plans	1510	4	6	U

TABLE D-3.- Continued.

Date	Item	Time	No. sheets	No. copies	Up (U) or down (D)
6/3 (Day 2)-concluded	Flight manifest	1520	1	3	U
	Meudon:	1520			
	Hardcopy		1	1	D
	Log sheet		1	1	D
	Notes on improving communication (U. Southampton)	1535	1	1	U
	Operations notes - U. Colo.	1535	1	1	U
	JPL to Operator D TAOF & 1/8-m UVS; operating instructions for flight 2	1610	1	1	U
	Tool list-Ames experiment, operator D	1615	2	1	U
	Operating procedure, JPL	1637	1	1	U
	Satellite photos 21:46 visual 21:16 IR	1650	2	1	U
	Meudon PI to operator A, operating instructions	1745	1	1	U
6/4 (Day 3)	ADDAS data tapes	0230	3 tapes	1	D
	ADDAS printout	0230	60	4	D
	QMC:	0300			
	Log sheets		5	1	D
	Stripchart		1 roll	1	D
	Meudon/Groningen:	0300			
	Stripchart		1 roll	1	D
	Hardcopy (minicomputer)		over 100	1	D
	New Mexico:	0430			
	35-mm film		1 roll	1	D
	16-mm film		2 rolls	1	D
	Checklist		2	1	D
	Stripchart		1 roll	1	D
	SH:	0430			
	Stripchart		1 roll	1	D
	Log sheet		1	1	D
	Alaska:	0430			
	Hardcopy (minicomputer)		15	1	D
	Stripchart		1 roll	1	D

TABLE D-3.- Continued.

Date	Item	Time	No. sheets	No. copies	Up (U) or down (D)
6/4 (Day 3)-concluded	Colorado:	0430			
	Tapes (cassettes)		2	1	D
	Hardcopy (minicomputer)		1	1	D
	JPL:	0430			
	X-Y plots		20	1	D
	Typed flight log (ADDAS)	0430	9	1	D
	Water-vapor tables (Mission Manager)	1435	12	1	U
	Troubleshoot procedures U. Colo. (PI to operator B)	1445	1	1	U
	Meudon stripcharts	1450	2 rolls	1	D
	QMC logbook	1535	4	1	U
	JPL daily operations plan	1555	2	1	U
	Passenger manifests	1640	1	3	U
	Meudon tape cassette	1700	1	1	D
	Flight plan	1700	4	1	U
	Flight plans	1730	4	10	U
	Satellite weather pictures	1730	2	1	U
	Meudon/Groningen star plots to operator A	1815	8	1	U
	Meudon operations procedures	1850	2	1	U
6/5 (Day 4)	Satellite photographs	1335	4	1	U
	Flight plans	1430	4	10	U
	Flight manifest	1533	1	3	U
	Satellite photos	1715	2	1	U
	Operating procedures	1715	2	1	U
6/6 (Day 5)	ADDAS data tape	0315	4 tapes	1	D
	ADDAS printout	0315	92	4	D
	QMC:	0425			
	Stripchart		1 roll	1	D
	Log sheets		2	1	D
	Polaroid film		9	1	D
	NM:	0425			
	Checklist		11	1	D
	Stripchart		1 roll	1	D

TABLE D-3.- Continued.

Date	Item	Time	No. sheets	No. copies	Up (U) or down (D)
6/6 (Day 5)- concluded	NM - concluded				
	35-mm film		1 roll	1	D
	16-mm film		1 roll	1	D
	Alaska:	0425			
	Hardcopy		20	1	D
	Log sheet		1	1	D
	Stripchart		1 roll	1	D
	Flight log (ADDAS)	0425	13	1	D
	JPL:	0425			
	X-Y plots		4	1	D
	Southampton:	0425			
	Stripchart		1 roll	1	D
	Ames data, 10" roll stripchart	0425	10" roll	1	D
	Note on flight planning, NM to Mission Manager	1320	1	1	U
	Southampton:	1325			
	35-mm film		1 roll	1	D
	X-Y plotting paper (blank) from storage locker to JPL	1330	40	1	U
	Flight 4 plans	1455	4	7	U
	Passenger manifest	1540	1	3	U
	Stripchart (10')	1550	1 roll	1	D
	Debriefing agenda	1605	2	1	U
	Flight plan (4 more copies)	1615	4	4	U
	Debriefing agenda	1635	1	5	U
	JPL experiment operations PI to operator C	1725	1	1	U
	Ames star charts to operator D	1725	4	1	U
	1500 weather pictures	1725	2	1	U
	JPL star plot PI to operator C	1905	1	1	U

TABLE D-3.- Continued.

Date	Item	Time	No. sheets	No. copies	Up (U) or down (D)
6/7 (Day 6)	ADDAS printout	0215	78	4	D
	ADDAS data tapes	0215	3 tapes	1	D
	SH: 35-mm film	0315	15 rolls	1	D
	New Mexico:	0315			
	35-mm film		1 roll	1	D
	16-mm film		1 roll	1	D
	Stripchart		1 roll	1	D
	Checklist		7	1	D
	Alaska:	0315			
	Hardcopy		30	1	D
	Stripchart		1 roll	1	D
	Stripchart		1 roll	1	D
	JPL: Hardcopy (X-Y plots)	0315	10	1	D
	Colorado:	0315			
	Stripchart (2 packs)		10 ft 4 ft	1	D
	Computer line print (minicomputer)		8 prints 10" roll, 5 ft	1	D
	QMC: stripchart	0330	1 roll	1	D
	Typed flight log (ADDAS)	0330	5	1	D
	Ames: 10" stripchart	0330	1 roll	1	D
	QMC:				
	Polaroid films	1220	10	1	D
	Stripcharts (2) #1 & #3		2 small rolls, 6" wide	1	D
	Southampton:	1220			
	Stripchart (1-1/2" roll)		1 roll 6" wide	1	D
	Log sheet		1	1	D
	Alaska:	1310			
	Brush chart (double) 3 ft		1	1	D
	X-Y plot-spectrum		2	1	D
	Flight plans	1330	3	2	U
	1815 weather pictures	1345	2	1	U
	Flight plans	1435	3	7	U
	JPL/TAOF spectrum	1520	1	1	D

TABLE D-3.- Concluded.

Date	Item	Time	No. sheets	No. copies	Up (U) or down (D)
6/7 (Day 6)-concluded	Meudon stripchart (15" wide)	1550	1 roll $2\frac{1}{2}$" diam	1	D
	JPL:	1625			
	Experiment modification instructions		1	1	U
	Flight operations		1	1	U
	Flight manifest	1627	3	1	U
	QMC log	1615	3	1	D
	QMC log	1705	3	1	U
	ADDAS printout	2330	30	4	D
	ADDAS data tapes	2330	4 tapes	1	D
	Southampton:	2340			
	35-mm film		1 roll	1	D
	Stripchart		1 roll	1	D
	Stripchart		1 roll	1	D
	Ames: stripchart	2340	1 roll	1	D
	New Mexico:	2340			
	Stripchart		1 roll	1	D
	35-mm film		1 roll	1	D
	16-mm film		2 rolls	1	D
	Checklist		6	1	D
	JPL X-Y plot hardcopy	2340	?	1	D
	Colo. hardcopy (minicomputer)	2340	1	1	D
	Alaska hardcopy (X-Y plot)	2340	13	1	D

TABLE D-4.- TRANSMITTED HARDWARE AND MAGNETIC TAPE RECORDS

Day	Experiment	↑ or ↓	Time	Transmitted item of material/comment
1	SH	↓	1650	Trial video transmission from prerecorded tape
	Alaska	↑	1530	Multimeter. Forgot to put aboard at start of confinement
	Ames	↑	1630	Dewar/detector. PI forgot to put onboard
2	SH	↓	0605	Transmit video data tape
	Meudon	↑	1550	Plastic sheet to seal telescope from cabin air
	Meudon	↓	1620	Transmit video star field using SH video recorder/reader
	Miss. Mgr.	↑	1710	Relative humidity meter
	SH	↓	1730	Transmit video star field from data tape
	Alaska	↓	1745	Blank magnetic tape. Do not need since tape recorder out
	Alaska	↓	1745	Spring from tape recorder. Fell out unnoticed when tape recorder removed
3	SH	↓	0250	Transmit video data tape
	Gröningen	↓	0850	Cassette tape recorder (no backup on ground)
	Gröningen	↑	1205	Cassette tape recorder to duplicate part of data tape
	Alaska	↑	1510	Tape recorder. Al. technicians wire in; EOs do not use
	QMC	↓	1530	Spare chopper motor. PI to start construction of improved chopper
	Meudon	↓	1547	Transmit video star field using SH video recorder/reader
	Gröningen	↓	~1600	Cassette tape recorder and cassette with duped data. (PI needs recorder to read tape)
	Gröningen	↑	1650	Four fuses for power supply
4	Gröningen	↑	~1200	Cassette tape recorder and blank cassette
		↓	1430	Cassette tape recorder and cassette with duped data
5	SH	↓	0425	Transmit video data tape
	JPL	↓	1345	Guide scope. Not in use. PI to modify
	Gröningen	↓	1800	Dewar/detector (EO usage ended)
6	SH	↓	0315	Transmit video data tape

obtained from monitoring the voice communications on channel 1. The tables show the experiment involved, what was transmitted, the time of transmission, how much (if more than one of a kind), and direction of transmission (U, ↑, or D, ↓).

Table D-5 summarizes the information in tables D-3 and D-4 concerning handcarried data items and EO instructions. On the left of the upper block are tabulated the number of transmissions made and on the right the quantity of data records and EO instructions. Transmissions considered appropriate, in theory, for telemetry included all printed material, information on tape, and hardcopy obtained from computer memory readouts (Groningen and Alaska). The facsimile-compatible materials were primarily weather satellite pictures and star charts. The flight plans always included a map, but were considered telemetry compatible because the flight crew really needed only the tabulated numerical information included in the plan. For tabulation purposes, flight plans were considered mission-related transmissions (rather than aircraft-related). ADDAS transmissions are included in table D-5, but with quantities listed separately. At the data rates employed in the mission, ADDAS accumulated approximately half a 9-in. reel of magnetic tape and 12 ft of line-printer readout per flight hour. The uplink transmissions often consisted of several copies of a given document (passenger manifest, flight plan, etc.); the duplicates are not included in the tabulations, however, since only the amount of original information transmitted is of interest.

The number of daily transmissions appears to be approximately constant for days that included a postflight downlink data dump — about 30, with about 20 down and 10 up. The number of down transmissions made on day 6 is high because this day included two postflight data dumps. EO transmissions fell sharply on days 1 and 4 when there were no flight data to transmit. The amount of information transmitted both down and up was unusually high on day 3. According to the logbook, operator A transmitted "over 100" sheets of hardcopy (IR maps) down to Meudon/Groningen (this is an IR map for about each 2.5 min of observation time). Uplink transmissions on the same day were augmented by a water-vapor table for the onboard Mission Manager and a new set of star charts for operator A. The totals at the bottom of the table show that only 53 percent of downlink items transmitted were telemetry compatible, whereas 78 percent of uplink items transmitted were telemetry compatible and 20 percent were facsimile compatible, nearly the entire amount. This is particularly significant since the quantity of downlinked experiment data (exclusive of ADDAS) was more than three times greater than that uplinked. Obviously, the PIs relied heavily on data records that were not compatible with a telemetry downlink, primarily to simplify experiment operations; for example, a strip-chart served both as a real-time indicator of performance and a postflight source of information for the PI.

The lower block of table D-5 indicates, by experiment, the items of hardcopy downlinked by the EO (data) and uplinked by the PI (instructions). In one case (JPL), the upflow exceeded the downflow, indicating that experiment operations were not routine or very productive of results. Transmissions not included in table D-5 consisted of pieces of equipment, and fall beyond the scope of this appendix. See Appendix B, Experiment Development and Performance, for an in-context discussion.

TABLE D-5.- SUMMARY OF HARDCOPY TRANSMISSION DURING JOINT MISSION

Day	Items transmitted							Quantity of experiment data records/instructions					ADDAS quantity	
		Number down		Number up				Down				Up	Down	
	Total number	Total	Telemetry compatible	Total	Telemetry compatible	Facsimile compatible	Aircraft related	Sheets	Magnetic tape	Film rolls	Strip-chart rolls	Sheets	Magnetic tape	Sheets
1	7	1	1	6	5	1	1	0	0 (1*)	0	0	19	0	0
2	34	25	18	9	8	1	2	68	0 (3*)	3	5	11	3	71
3	33	23	14	10	8	2	5	>147	4 (2*)	3	7	38	3	69
4	7	1	1	6	4	2	3	0	1 (0)	0	0	13	0	0
5	30	19	9	11	7	3	1	47	0 (1*)	4	6	21	4	105
6	48	41	15	7	6	1	2	92	0 (1*)	21	15	16	7	113
Total	159	110	58	49	38	10	14	354	5 (8*)	31	33	118	17	358

*Transmitted by cable.

Number of transmissions, by experiment			
Down by EO		Up by PI	
NM	20	JPL	10
SH	18	MEU	5
ALA	15	AMES	2
MEU	12	QMC	2
QMC	11	SH	1
JPL	6	ALA	1
COLO	6	COLO	1
AMES	3	NM	0
TOTAL	91	TOTAL	22

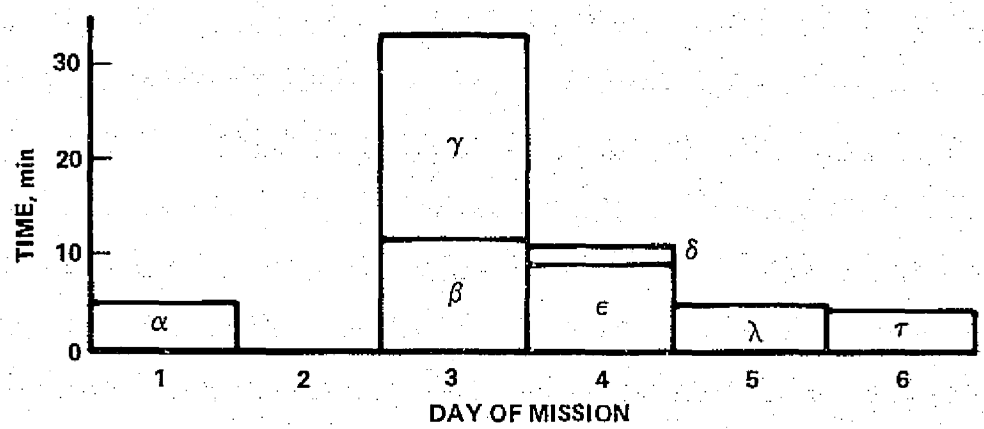
The hardcopy transmitted from EOs to PIs provided evidence that the EOs did not understand some of the details of data processing as well as they might have. The evidence took the form of comments by several PIs (in the overall mission debriefing) that the hardcopy they had received was not annotated completely enough for them to evaluate the data recorded on it. That is, apparently the EOs did not realize all that it was important for the PI to know (e.g., gain setting, time constants, modulation frequencies, sweep speeds) to evaluate the data record. Why these PIs did not make this lack of information known directly to the EOs is not clear. The EOs indicated that they certainly could have provided more complete information had they realized the need existed. Thus, although these omissions could possibly reflect the tight scheduling imposed on the EOs, they appear more likely to reflect inadequate exposure of the EOs to the data evaluation process.

Another form of hardcopy transmitted from the aircraft to the PIs was the flight log typed into the ADDAS record by the onboard mission stenographer. This contained real-time information about the observing conditions (aircraft stability, cloud cover, etc.), and such remarks as the EOs chose to record about experiment operation. This mode of communication was never effectively developed; the generally sparse comments were of marginal usefulness to the PIs in determining how well their experiment performed and what might need to be done during the succeeding work day. As a result, the PIs were forced to rely on verbal communication with the EOs over voice channel 1, briefly during the flight debriefing and more extensively after the EO sleep period. Despite PI requests for more extensive EO commentary on real-time experiment performance, the busy work schedule of the EOs apparently prevented the routine use of the aircraft intercom for this purpose.

Television Downlink

The television downlink consisted of one fixed camera positioned to view the surface of the operators' desk, one portable camera with stand, and one monitor in the aircraft cabin. Three displays were located in the MOC (fig. D-1). Although the communication ground rules allowed use of the video downlink only when necessary, it was found desirable to personalize some pre- and postflight meetings by visual contact with the simulation crew.

Figure D-5 indicates the use of the video downlink for specific tasks, which are identified in the list below the graph. Total use was only approximately 56 min, and only in cases β and γ was the video facility perhaps of critical importance. In the other cases, the video facility was of considerable value but by no means essential. In the β case, while transferring liquid helium into a dewar, the EO had broken off a baffle that damped undesirable pressure oscillations in the helium gas above the liquid. The video link allowed the PI to instruct the EO in the repositioning and resoldering of the baffle. In the γ case, the PI wished to inspect the detector wiring as a possible source of trouble. Some optical elements had to be removed and then reassembled after the inspection. The PI provided step-by-step instructions to the EO.



α ≡ transmission of mercury calibration spectrum

β ≡ PI instructions to EO during solder repair job

γ ≡ PI instructions to EO during disassembly and reassembly of dewar optics to visually inspect detector wiring

ε ≡ PI/EO joint experiment operational check

δ ≡ transmission of mercury calibration spectrum

λ ≡ PI evaluation of stripchart ink reservoir problem

τ ≡ transmission of Sun calibration spectrum

Figure D-5.– Video downlink usage.

In the other cases: α and δ were displays of calibration spectra taken during the course of operational checkout prior to takeoff (transmission reassured the PI that all was well); in ε, the PI assured himself and the EO of the proper experiment operation by observing certain readouts; and in λ, a PI had analyzed a stripchart recorder inking problem as being "out of ink" (the EO demonstrated that this was not so by showing the PI the plastic ink reservoir). In τ, the EO displayed a hardcopy of a calibration spectrum just taken (at PI request) using the Sun as the source. It was subsequently (~1 hr after the transmission) downlinked down as hardcopy.

Although the video downlink was used only seven times for specific tasks, its value was adequately demonstrated on day 3 when two experiment problems were resolved with close support from PIs. On days 4 and 5, the video was used for real-time experiment checkout, and on three other occasions visual images of data records (not compatible with telemetry) were transmitted to verify experiment performance.

Telephone Communications

Table D-6 indicates the use made of the onboard phone located optionally at the Mission Manager's station in the cabin or in the living quarters (liftvan). The table gives the caller, the recipient, the time, and, if not personal, the subject. A record of call duration was not required.

Voice communications other than via channels 1 and 2 were intended (except in emergencies) to be nonmission related. As can be seen from the table, this rule was not observed at all; over half of the 42 calls placed on the liftvan phone were directly related to mission activities. It would appear that this usage was primarily a matter of convenience either to the person initiating the call or, in some cases, the recipient of the call, when the latter was only peripherally associated with the mission and not generally at the MOC. No mission-related phone calls were placed during periods when the record shows voice channel 2 was busy. Note that one long PI/EO conversation took place via the liftvan phone (June 7, 1445 hr). This PI was seldom in the MOC and had to be sought out by the EO in his laboratory elsewhere at Ames.

The PIs made normal use of the five telephones linking the MOC to the outside world. There were two calls placed to home laboratories and six others to various companies to discuss equipment repair. Eight calls were placed to local vendors of various commodities and services. This use rate is about normal for ASO flight programs, except for calls to home laboratories. During other missions, calls to home laboratories have been made more frequently. It is possible that such calls were made during this mission from telephones other than those in the MOC and simply not recorded.

Summary of Audio/Video Communications

Table D-7 summarizes voice channel, telephone, and video communications during the simulation period in terms of number of events and time required of

TABLE D-6.- LIFTVAN TELEPHONE LOG

From	To	Time	Subject
		June 3	
Mission Manager	MOC	1240	Fouled liftvan plumbing
Operator D	Home	1315	
Operator A	Home	1330	
Mission Manager	MOC Mission Scientist, Mech. Engineer	1515	Unplugging plumbing, condensation on mylar, Lear Jet operations
Mission Manager	Operations Manager	1628	Removal of cryogenic facilities
Operator A	Prime PI	1648	Personal
Mission Manager	Home	1900	
		June 4	
Mission Scientist	Mission Manager	1300	Flight plans
Mission Manager	Pilot	1330	Status of aircraft; contingency flight plans
Mission Scientist	Mission Manager	1335	Alternate flight plans
Mission Manager	Operations Manager	1338	Power off aircraft because crew servicing oxygen
Operations Manager	Mission Manager	1339	Whereabouts of Southampton film
Operator A	Home	1355	
Operator D	Home	1430	
Mission Manager	ESA Representative	1508	Mission status
Mission Manager	ESA Representative	1520	Further on mission status
ESA Representative	Mission Manager/ Operator D	1525	Reinstallation of Alaska tape recorder
Operator D	Flight Research Center (FRC)	1530	Other NASA business
Mission Manager	ASO chief	1620	Mission debrief
↓	Home	1820	
↓	MOC	1945	Projected flight schedule
↓	MOC	2400	Results of maintenance flight

TABLE D-6.- Concluded.

From	To	Time	Subject
		June 5	
Mission Scientist	Mission Manager	1015	Flight plans
Operator D	FRC	?	Other NASA business
Operator D	FRC	?	Other NASA business
		June 6	
Mission Manager	NASA Headquarters	1050	Other NASA business
Operator D	Johnson Space Center (JSC)	1100	
	JSC	1110	
	Home	1115	
	JSC	1330	
Mission Scientist	Mission Manager	1445	Change in flight plans
Operator B	MOC	1510	Personal
Mission Manager	Home	1540	
Ames Flight Operations	Mission Manager	1545	Schedule of PI flights
Mission Manager	Ames Flight Operations	1550	Flight schedule for PI flights
Mission Manager	Ground crew chief	1555	Flight schedule for PI flights
Mission Manager	MOC	1825	? (voice channels 1 and 2 already removed for flight)
		June 7	
Operator D	Local motel	1200	Personal
Operator D	Prime experiment PI	1445	Prime experiment operation (20 min)
Mission Manager	Home	1810	

TABLE D-7.- SUMMARY OF AUDIO/VIDEO COMMUNICATIONS WITH SIMULATION CREW (MISSION RELATED)

Comm. system	Mission Manager		Expmt. Opers. (4)		Full crew	
	Events	Time, min	Events	Time, min	Events	Time, min
Voice channel 1	5	20	172	780	11	375
Voice channel 2	33	29	3	3	Preflight and debriefing mtgs.	
Telephone	21	100 (est)	2	25 (est)		
Video downlink	0	0	7	56		
TOTALS	59	149	184	864	11	375
Avg. time per event	2.5 min		4.7 min		34.1 min	

	Communication time, min		
	M.M.	E.O.s (4)	All (5)
Individual	149	864	1013
Group	375	375	375
TOTALS	524	1241	1388
% of total time	6.7	15.9	17.8

the onboard crew. About 240 contacts between individuals and 11 group meetings were observed. The Mission Manager (onboard) averaged 11 mission-related contacts a day of about 2.5 min duration; the average for individual EOs was eight of about 4.7 min each. Single contacts varied from less than 1 to over 20 min.

The Manager spent some 6 to 7 percent of the total simulation period in communication, while the EO average was about 4 percent. Considering only the groundwork time as a base, the corresponding values are 25 and 15 percent. Overall, one or the other of the audio/video systems was in use nearly two-thirds of the time available on the ground (some 6-1/2 hr a day).

CONCLUDING REMARKS

As a facility, the audio-communications system employed during the first Joint Mission was adequate: Use of voice channel 1 was fairly high early in the EO working day when all PIs wanted to establish experiment status and to initiate any required nonroutine EO activities, but the necessary exchanges were made with ample time to spare. The communications difficulties that arose were all associated with a lack of understanding between the EOs and PIs: the EOs not supplying sufficient information to the PIs, and the PIs not informing the EOs of the deficiency. More thorough EO training would probably have prevented the situation from arising.

Use of the personal/emergency phone provided the only major deviation from planned usage of communications facilities. Rules for its use should be made more explicit in any future simulation.

The first Joint Mission did not fully test the utility of the television downlink facility. Its infrequent use can perhaps be attributed to a lack of EO training on the equipment. Even so, there were several occasions when its value was demonstrated for troubleshooting and repair of equipment, and to downlink visual images of hardcopy not suitable to telemetry. This latter use would have been much more extensive if limits had been placed on the downlink simulation (handcarry) of such noncompatible material. All participants felt that the TV link was most desirable and all could think of situations where its availability would be vital.

Hardcopy transmittal was used extensively, with downlink use more than a factor of 3 greater than uplink use. Of the former, only about half were telemetry compatible, while almost all of the uplink copy could have been telemetered at a rate of 3 pages per hour.

APPENDIX E

MISSION DOCUMENTATION

MISSION POLICY DOCUMENTS

NASA/ESA Correspondence

Although initial mission planning commenced in February 1974 and a draft of an interagency agreement was approved at the June MPG meeting, the joint participation of NASA and ESA was not fully formalized until August 1974. At that time, letters were exchanged between NASA and ESA headquarters to invite ESA participation and in reply to accept the invitation.

Premission Planning

Following is a short summary of early policy planning on this project, taken from notes prepared by a representative of NASA HQ.

In the fall of 1972 a series of informal discussions were initiated between NASA and ESA to explore the potential value of having ESA participate in ASSESS. These discussions continued throughout the third quarter of 1972 and the first quarter of 1973, when the loss of the CV-990 Galileo I on April 12, 1973 placed the entire ASSESS program in jeopardy. This loss proved to be only a temporary setback since NASA immediately decided to replace the CV-990 with another airplane with similar operational characteristics.

With the decision to replace the airplane, the Director of the NASA Sortie Lab Task Force contacted the Head of the Spacelab Programme (ESA) to invite ESA to participate in ASSESS in two ways: "As a Principal Investigator" and/or "as an observer of United States Experiments." The Director further requested ESA identify a person as principal point of contact for further planning discussions.

No further activity occurred on ESA participation in ASSESS until the fall of 1973, when discussions were reestablished. In January 1974, ESA appointed a representative to work with NASA in planning ESA participation. Meetings were held on February 2, 3, and 4, 1974, during a series of CV-990 Airborne Science flights, between representatives of NASA and ESA to discuss preliminary plans for a cooperative mission. These meetings resulted in defining as a goal the conduct of a joint mission, utilizing the CV-990. Representatives of both participating organizations (NASA and ESA) reviewed these goals with their respective managements, and implementation of preparation for a joint mission began with ESA's release of an Announcement of Flight Opportunities on NASA/ESA Spacelab Payload simulation flight on February 27, 1974.

The meetings of early February 1974 constituted the first formal planning for the mission. The notes on the meetings show that the mission guidelines were developed much as they are given in the Mission Operating Plan (attachments). A preliminary listing of important mission milestones was also developed.

Mission Planning Group (MPG)

This group, set up jointly by NASA and ESA, following the preliminary planning meeting of February 1974, provided the basic policy direction for the mission. The directives of the MPG were carried out by the Mission Manager and his staff who prepared additional documentation as required. Guidelines for the conduct of the mission were developed by the MPG. These guidelines are given in the Mission Operating Plan.

Mission Planning Group meetings are listed below. Minutes were prepared for all but the final meeting of May 22-23, 1975.

May 1, 1974	NASA HQ, Washington, D.C.
June 7-8, 1974	Ames Research Center, Moffett Field, CA
September 12, 1974	NASA HQ, Washington, D.C.
November 19 & 22, 1974	ESA HQ, Neuilly-sur-Seine, France (in conjunction with Experimenters Meeting)
May 6 & 7, 1975	Ames Research Center, Moffett Field, CA
May 22 & 23, 1975	Ames Research Center, Moffett Field, CA

MISSION PLANNING DOCUMENTS

European Space Agency

<u>Announcement of Flight Opportunity</u>

The ESA Announcement of Flight Opportunity on NASA/ESA Spacelab Payload Simulation Flights scheduled for March 1975 on the Convair 990 aircraft was dated 27 February 1974 and signed by the ESA Director General.

<u>Proposals from Experimenters</u>

Proposals were received from a number of experimenters following the circulation of the AFO. These proposals were evaluated by ESA, and at NASA HQ in May 1974. Much of the material from these proposals is reproduced in Appendix B, Experiment Development and Performance.

Operator Solicitation

ESA selection of operator A as the experiment operator for the Meudon/Groningen experiment was a natural. He was assigned as a visiting scientist to ESTEC (part of ESA), and he was an infrared astronomer. For their second EO, ESA wished to choose a graduate student with no professional experience as an investigator. After talking with several candidates suggested by the investigators, a student was selected as a qualified candidate who was willing to delay his graduate studies for the time required by the mission. (EO-B)

National Aeronautics and Space Administration

Proposals from Experimenters

A tentative selection of experiments comprising the University of Alaska, the University of Oregon, and the Ames Research Center had been made by the time of the June 1974 MPG meeting. No AFO was issued for this mission; informal solicitation of prospective experimenters by the Mission Manager was approved by Headquarters. Subsequently, these and several other experimenters submitted formal proposals, from which the cognizant Headquarters program office selected a combined experiment from Alaska and JPL, the Ames experiment, and the experiment from the University of New Mexico. It should be noted that JPL and Alaska initially had prepared separate proposals, and although the JPL PI was designated as the PI for the combined experiment they each maintained a separate identity until well into the period of active preparation. On the other hand, the JPL proposal included an instrument from the University of Colorado that subsequently developed a separate identity under the direction of an experimenter from that university. Descriptive material from these proposals is reproduced in appendix B.

Proposals received from U.S. experimenters were dated as follows:

JPL	July 1974
New Mexico	August 1974
Alaska	June 1974 October 1974 (rev.) November 1974 (rev.)
Ames	June 1974

Operator Solicitation

The MPG selected an astronomer from Yerkes Observatory and a scientist/astronaut from JSC as experiment operators. The selections were confirmed in letters from Headquarters dated October 7, 1974.

Following the final Experimenters Meeting at ESA Headquarters in November, the Yerkes astronomer dropped out of the program, indicating that he could not spare the time required. He was replaced, after about 2 months, by a spectroscopist (operator C) from the University of Maryland who had participated in the development of the Alaska instrument.

JSC eventually switched assignments, replacing their first designee with another scientist/astronaut (operator D). This second change was made in February 1975 and confirmed by the MPG at its March 1975 meeting.

MISSION IMPLEMENTATION DOCUMENTS

Joint Mission funding was implemented through normal channels in both agencies. Aircraft operations and basic experiment costs were documented by the Mission Manager and approved by the Office of Space Sciences (OSS) at NASA Headquarters, as for a regular ASO mission. ASSESS-specific experiment costs and training expenses for the two U.S. EOs were funded by the Office of Space Flight (OSF). The services of one EO were obtained by contract to the ASO.

An experienced CV-990 Flight Director of the Airborne Science Office (ASO) was designated as the Mission Manager by the MPG at their May 1974 meeting. In this capacity he was the single point of contact between the investigators and the ASO as well as all mission support groups. This relationship is illustrated in figure E-1. As Mission Manager he prepared and distributed various documents in the course of his assignment. General mission documentation is discussed first, followed by a listing of specific documentation used for each period of the mission. An overview of mission documentation is given in figure E-2.

General Documentation

Mission Operating Plan

The Mission Operating Plan, prepared by the Mission Manager, is the basic mission policy and planning document. It collects the directives of the MPG and sets them out in a complete program plan for the mission. It includes the basic objectives of the mission, the guides developed by the MPG to implement these objectives, a detailed operations plan, and the mission schedule. The document also describes the experiments selected, their arrangement in the aircraft, and available support items for the experimenters, and it outlines provisions for the handling of experimental data.

The first edition of this document was distributed at the Experimenters Meeting at ESA Headquarters in November 1974. It was revised following the November MPG meeting and reissued in January 1975. This final version is the one presented in the attachments to this appendix.

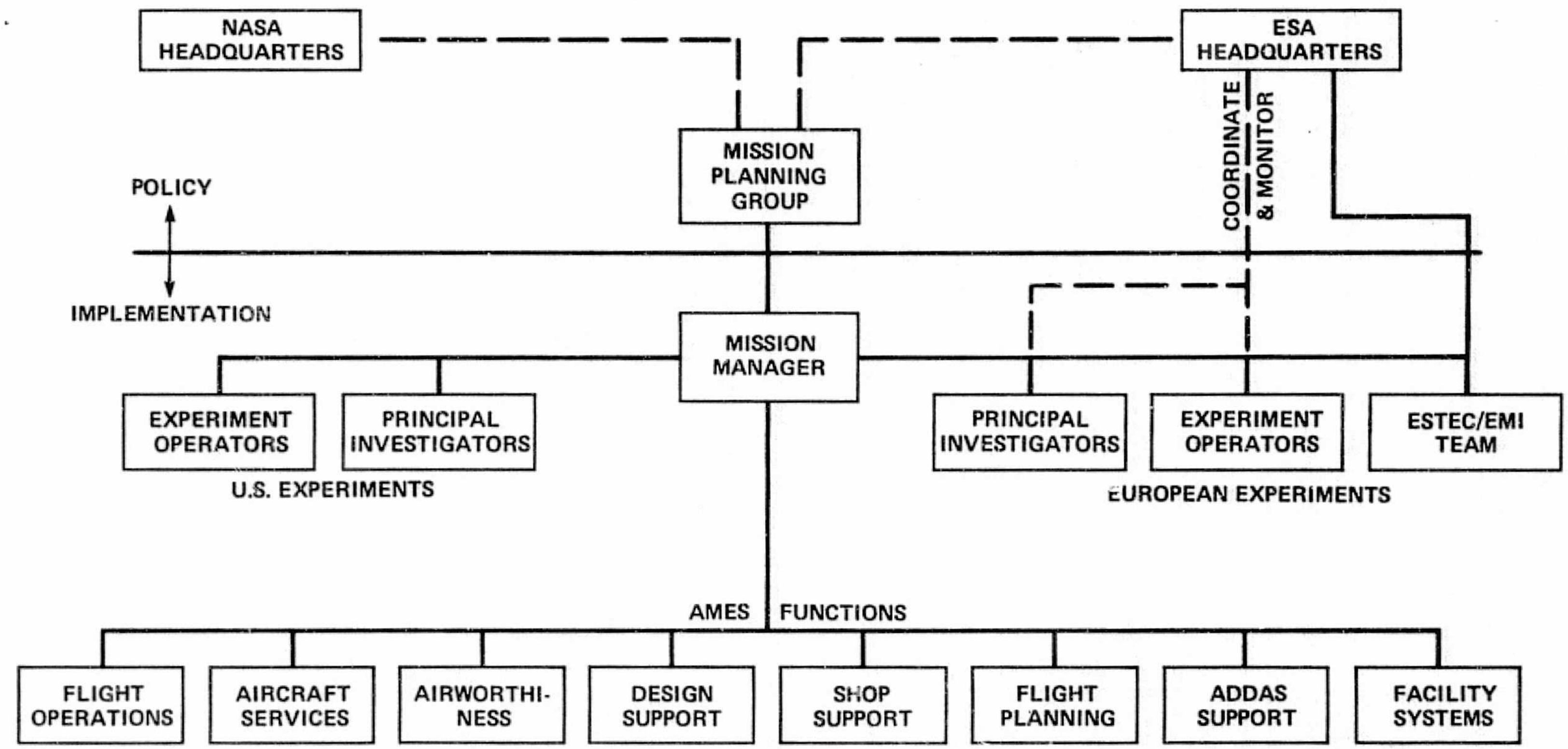


Figure E-1.- Joint Mission organization for the preparation period.

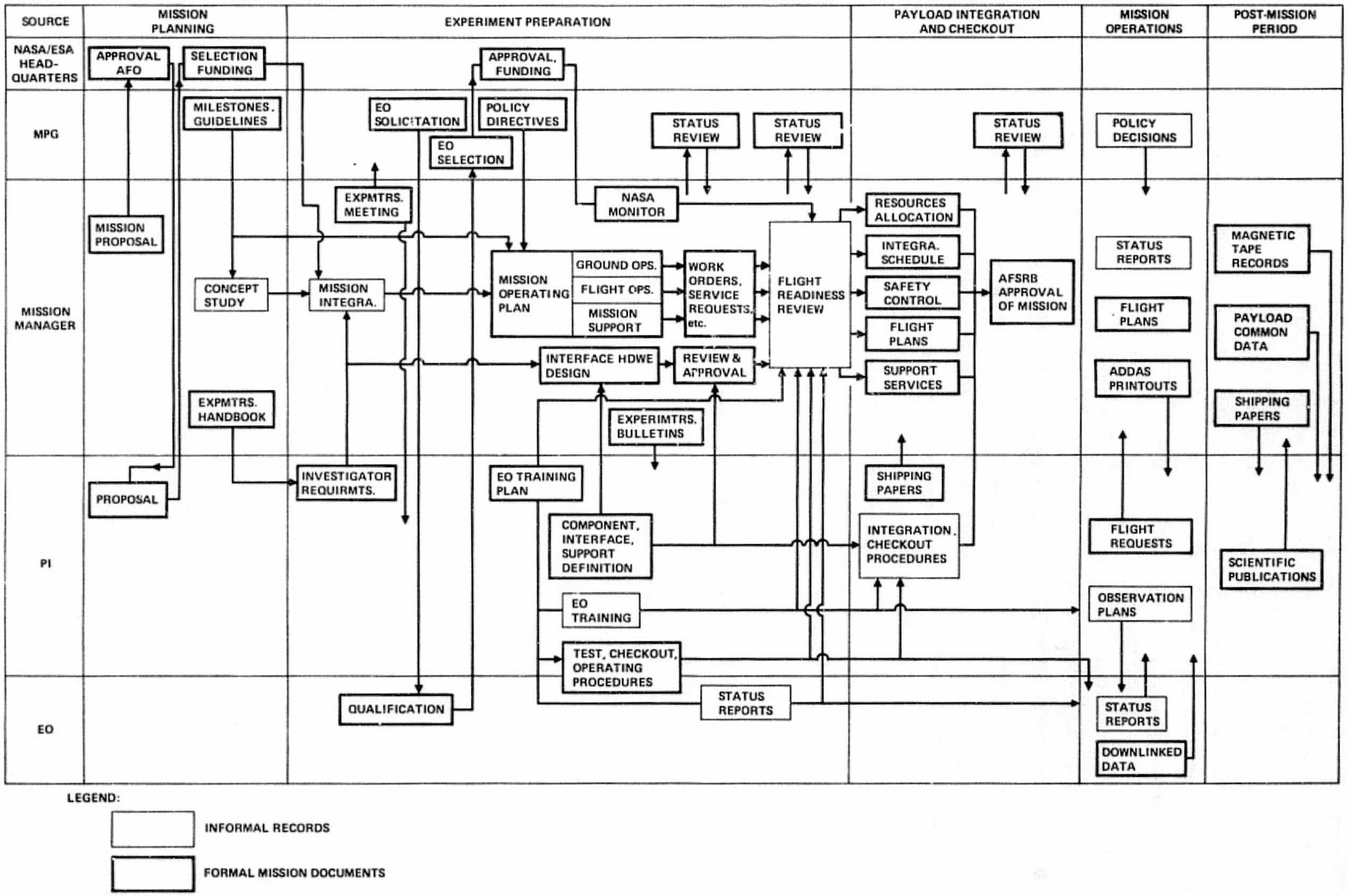


Figure E-2.- Overview of mission documentation.

CV-990 Experimenters' Handbook

The CV-990 Experimenters' Handbook is a required reference for all experiments to be flown on the aircraft. The handbook describes the aircraft, its capabilities, special equipment installed for the benefit of experimenters, special equipment available to experimenters, and requirements for stress analysis of equipment to be installed in the aircraft. Copies were distributed by the Mission Manager.

The edition of the Handbook used on this mission was not completely up to date on all modifications of the aircraft. In addition, some of the experimenters had difficulty in interpreting the requirements for their equipment and made some suggestions for improved presentation of information. A supplement to the Handbook has been prepared as a result of the experience on this mission for the benefit of future experimenters on the CV-990, and, in particular, for the benefit of foreign experimenters on the second Joint NASA/ESA Mission planned for mid 1977.

Minutes of Experimenters' Meetings

Because of the special nature of this mission and the need to inform experimenters unfamiliar with the aircraft about its characteristics, several experimenters meetings were held as listed below. Minutes were prepared for all of the meetings except the first.

June 6 & 7, 1974	Familiarization Meeting — Ames Research Center, Moffett Field, CA. For all experimenters, European and U.S.
September 25, 1974	ESTEC (European Space Research and Technology Centre), Noordwijk, The Netherlands — for European experimenters
October 18, 1974	Ames Research Center, Moffett Field, CA — for U.S. experimenters
November 20 & 21, 1974	ESA HQ, Neuilly-sur-Seine, France — for all experimenters, European and U.S.

Initial drafts for these minutes were prepared by the ASSESS Observer Team with the final versions issued by the Mission Manager.

Experimenters' Bulletins

It is standard ASO practice for the Mission Manager to issue bulletins providing detailed mission information to experimenters. These bulletins also may request information from the experimenters as to their interfaces with aircraft systems. Two such bulletins were issued for the Joint Mission.

The first bulletin was issued in March 1975 and gave time blocks for major elements of the mission schedule, described the Experiment Readiness Review procedure, requested information about personnel to be involved with the mission, and requested final confirmation of data inputs to ADDAS.

The second bulletin, issued in April 1975, presented a revised floor plan of the aircraft (an earlier plan had been given with the Mission Operating Plan), a more detailed schedule of the integration and flight periods of the mission, reiterated the request for ASSESS-specific information made at the November Experimenters' Meeting, and listed principal participants in the mission.

Both of these bulletins are among the attachments to this appendix.

Preparation Period Documentation

During the mission preparation period, mission management documentation consisted largely of direct correspondence between the various investigators and the Mission Manager, with informational copies to Headquarters offices. The amount of correspondence on any experiment was governed by the complexity of the equipment and the experimenter's need for support services. When time was critical, telephone communications were logged by the Mission Manager.

Communications from investigators to the Mission Manager included those on the following subjects:

- Equipment arrangement in standard racks, and provision for electrical isolation and grounding of components
- Equipment drawings and stress analyses for unique experiment mounting hardware
- Requests to Ames for design and fabrication of interface hardware, either for common use by more than one experiment, or where the interface was exposed to outside ambient pressure and/or aerodynamic loads
- Requirements for optical ports (special window materials in standard openings)
- Requirements for ADDAS interfaces — data recording, data processing, and housekeeping parameters
- Requirements for electrical power and cryogenics
- Requirements for special equipment, such as vacuum pumps
- Lists of astronomical objects for viewing so that preliminary flight plans could be developed
- General observational requirements other than stellar or planetary objects
- EO training plans

Communications from the Mission Manager to the investigators included:

- Requests to investigators for information as to all required aircraft interfaces and experiment support facilities (ground and flight)

Responses to investigators' inquiries on specific hardware/ software interfacing problems

The Mission Manager also was responsible during this period for other documentation as listed here:

All required documentation for design, stress analysis, safety approval, and special interface hardware (48 production drawings)

Transmission of ADDAS requirements to the ADDAS programmers and operators

Information on the mission schedule to the Flight Operations Branch to permit training and assignment of flight crews (flight request)

Information on the mission requirements and the experiments to the Airworthiness and Flight Safety Board to permit their evaluation and approval of the mission

Shipping requests for shipment of racks to investigators

The development by ASO flight planners of a number of flight plans to meet the requirements of the various experiments (see Mission Operating Plan for an example)

Request for refurbishment and testing of optical window inserts by R.&Q.A. support contractor to satisfy experiment requirements (see fig. E-3 for examples)

Plans and implementation of engineering flight tests of IR port configuration for Meudon telescope, including instrumentation of aircraft fuselage and evaluation of panel buffet data

Experiment Readiness Reviews

The outline of these reviews was given to each experimenter in early March and formalized in the first Experimenters' Bulletin (attachments). No formal record was made of each review. An ASSESS observer attended the on-site European reviews and made informal notes. Two U.S. reviews were conducted by conference telephone and one, for the Ames experiment, in person. The Observer Team prepared informal notes on these reviews.

It is expected that this procedure will need to be strengthened for Spacelab use and that the documentation will become somewhat more formal.

The reviews were held as listed below:

University of New Mexico — by phone	March 21, 1975
Queen Mary College, London, England	March 25, 1975
University of Southampton, Southampton, England	March 27, 1975
Observatoire de Meudon, Meudon, France	April 1, 1975

MAY 14, 1975

NASA/AMES RESEARCH CENTER
CV-990 AIRBORNE LABORATORY (NASA 712)

OPTICAL WINDOW CHECK LIST

EXPEDITION: 1975 CV-990 NASA/ESRC CODE: 75-101

EXPEDITION MANAGER: L. Haughney EST. DEPART DATE: 05-15-75

AIRCRAFT			WINDOW DATA		DATES				
STA.	POS.	EXPERIMENTER	SERIAL NUMBER	LENS MATERIAL	TEST	CLEAN	NEED	INSTALL	INSP.
432/451	14°	QUEEN MARY College	131	POLY-ETHYLENE	4/9	4/9	5/15	5/8	
584/603	14°	University OF NEW Mexico	027	BSC	5/13	5/13	5/15	5/16	
622/641	14°	UNIVERSITY OF NEW MEXICO	038	BSC	5/13	5/13	5/15	5/16	
816/833	14°	JPL/TAOF	101	BSC	4/16	4/16	5/15	5/16	
983/1002	14°	JPL/ALASKA	052	QUARTZ	5/14	5/14	5/15	5/16	
527/546	14°	University OF NEW MEXICO	043	BSC	5/12	5/12	5/15		
603/622	14°	University of NEW MEXICO	093	BSC	5/13	5/13	5/15	5/16	
546/565	65°	University OF Southampton	102	Pyrex	5/14	5/14	5/15	5/16	
584/603	65°	University OF Southampton	084	Pyrex	5/12	5/12	5/15	5/16	
833/851	65°	JPL/TAOF	016	QUARTZ	4/17	4/17	5/15	5/16	
983/1002	65°	SPARE ~~JPL/ALASKA~~	020	QUARTZ	5/15	5/15	5/16	5/16	✓
1040/1059	65°	ALASKA	021	QUARTZ	5/14	5/14	5/15	5/16	
1078/1097	65°	ALASKA	015	SODA LIME	4/15	4/15	5/15	5/16	
508/527	65°	University OF Southampton	040	PLEXI Dome	4/15	4/15	5/15	5/13	
	65	SPARE	025	QUARTZ	4/16	4/16	5/15	B Stores	✓
	14°	SPARE	026	QUARTZ	5/19	5/19	5/19	B-STORES	✓
	65°	SPARE	036	Soda Lime	4/14	4/14	5/15	B Stores	✓
	65°	SPARE	037	SODA LIME	5/15	5/15	5/15	B Stores	✓
	65°	SPARE	123	CORNING CORTRAN	4/11	4/11	5/15	B-Stores	✓

PER 061 (SEP 71)

(a) Window requirements.

Figure E-3.- Sample documents for CV-990 optical windows.

page 1 of 2

NASA-AMES RESEARCH CENTER
TASK ORDER REPORT

NO. F-492

TO: John Roller via L. Benbow	DATE: April 29, 1975
	MAIL STOP: N-211-12/244-5
JOB ORDER: T-5423 / CONTRACT NO. NAS2— —	SECURITY CLASSIFICATION
PROJECT: 1975 CV-990 Nasa/Esro assess	CLASS OF PROGRAM ACTIVITY: II A

(CHECK ONE)
☐ PROGRESS REPORT FOR MONTH OF ______ ☒ FINAL REPORT

TASK DESCRIPTION (Brief)

① Test 2 polyethylene windows per FRS-P-1000E.
② Make deflection measurement on 1 window.

REPORT (Summarize and list attachments where applicable)

① Proof pressure, leak, and environmental tests were successfully conducted on 4/25/75 as specified in FRS-P-1000 E for 2 ea. 41 mm 7 inch diameter polyethylene windows. See attached test data sheets.

② Deflection v.s. pressure/temperature were conducted for a six hour period to observe any "creeping". Specific data is shown on the attachment A. With a constant pressure of 8.30 psid and temperature Δ of 160° F, there is a .036 inch deflection at the window center. The "creep effect" over the six hour soak is negligible; < .001 inch. A residual deflection of .007 inch was recorded at the end of the 6 hour soak - 8.30 psid and ambient temperature.

ASSIGNED ENGINEER	MAIL STOP	PHONE EXT.
Howard Mercke / D. Yewan	N-244-20	6048/6175

APPROVED	INITIAL	DATE
RESPONSIBLE ENGINEER	SAB	4/30
BRANCH CHIEF		

REVIEWER	DATE
GeoB	5-1-75

ARC 286b (Rev. Jul 72)

C.C. D. Gawan

☆ GPO 792-392

(b) Test report for polyethylene window, Station 432-451.

Figure E-3.- Continued.

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

page 2 of 2

NASA-AMES RESEARCH CENTER
TASK ORDER REPORT

NO. F-492

DATE: April 29, 1975

TO: John Reller via S. Barbour

MAIL STOP: N-211-12/244-5

JOB ORDER: T-5423

CONTRACT NO.: NAS2—

SECURITY CLASSIFICATION:

PROJECT: 1975 CV-990 Nasa Eric assess.

CLASS OF PROGRAM ACTIVITY: II A

(CHECK ONE)
☐ PROGRESS REPORT FOR MONTH OF ____________

☒ FINAL REPORT

TASK DESCRIPTION (Brief)

REPORT (Summarize and list attachments where applicable)

(3) Each window has been identified and assigned a serial number and will be incorporated into the REGA CV-990 optical window Inventory Program. The serial numbers are 131-B-2 and 131-B-3.

(4) continuity checks of each thermistor were made upon completion of the environmental testing and deflection measurements. Both thermistors are still intact and indicate ≈ 1 ohm of resistance.

(5) S/N 131-B-3 is currently installed in a 14° frame. SN 131-B-2 & SN 131-B-1 (previously tested) are located in the REGA Bonded Store.

ASSIGNED ENGINEER: Howard Mancke / D. Gowan

MAIL STOP: N-244-29

PHONE EXT.: 6048/6175

APPROVED	INITIAL	DATE
RESPONSIBLE ENGINEER		
BRANCH CHIEF		

REVIEWER: GeoB

DATE: 5-1-75

ARC 286b (Rev. Jul 72)

cc. D. Gowan

☆ GPO 792-392

1. Originator of Task Order (White)

(b) Concluded.

Figure E-3.- Continued.

CV 990 OPTICAL WINDOW
PROOF PRESSURE AND ENVIRONMENTAL TESTS

6.0 TEST DATA SHEET

WINDOW S/N 131-B-2 DATE: 4/23/75

6.1 Paragraph 5.1 LEAK TEST ($\leq$0.1 psi/min)

STARTING PRESSURE (~5 psi) 5.0 psi

AFTER 5 MINUTES 5.0 psi LEAKAGE 0 psi/min

6.2 Paragraph 5.2 PROOF PRESSURE TEST (3 cycles, 5 min. each)

CYCLE	TIME		PRESSURE (27 $\pm$1 psig)
	START	COMPLETE	
1	9:48	953	26.95
2	12:41	9.46	26.95
3	13:00	13:05	26.95

6.3 Paragraph 5.3 ENVIRONMENTAL TEST

TIME	PRESSURE		ΔP (19.1 psia)	TEMPERATURE (°F)		ΔT (160°F)
	CHAMBER	CABIN		CHAMBER	CABIN	
START (0 min)	2.313	6.70	19.087	-66	95	161
5 min	2.367	6.75	19.083	-64	94	158
10 min	2.367	6.75	19.083	-66	95	161
15 min	2.367	6.75	19.083	-66	94	160
STOP (20 min)	2.367	6.75	19.083	-67	94	161

3 MINUTE SHUTDOWN (Paragraph 6.3.6) ΔP: 0 psig ($\leq$ 1.0 psia)
ΔT: 40 °F. ($\leq$ 100°F.)

AVERAGE ΔP: 19.084
AVERAGE ΔT: 160

WINDOW TYPE (LENS MATERIAL) Polyethylene

COMPLETE SERIAL NUMBER 131 B-2

EXPEDITION (IF KNOWN) Spare 1975 [illegible]

QUALITY ASSURANCE REPRESENTATIVE:

Dave Fower STAMP:

NCR(s) None

DUPLICATE COPY
F492
5-1-75

(c) Test record for polyethylene window, normal procedures.

Figure E-3.- Continued.

ATTACHMENT A

Polyethylene Window
S/N 131-B-3

Task Order F-492
April 30, 1975

Deflection vs. Pressure/ Temperature

TIME	PRESSURE	Temperature CHAMBER	Temperature CABIN	DEFLECTION IN INCHES
08:30	8.3	$+74^{\circ}$F	$+84^{\circ}$F	0
09:00	8.3	-64°F	$+95^{\circ}$F	.035
09:30	8.3	-64°F	$+90^{\circ}$F	.033
10:00	8.3	-60°F	$+99^{\circ}$F	.035
10:30	8.3	-60°F	$+100^{\circ}$F	.036
11:00	8.3	-60°F	$+101^{\circ}$F	.037
11:30	8.3	-60°F	$+101^{\circ}$F	.037
12:00	8.25	-60°F	$+99^{\circ}$F	.036
12:30	8.3	-60°F	$+98^{\circ}$F	.036
13:00	8.3	-60°F	$+99^{\circ}$F	.036
13:30	8.35	-60°F	$+99^{\circ}$F	.036
14:00	8.3	-60°F	$+100^{\circ}$F	.036
14:30	8.3	-60°F	$+100^{\circ}$F	.036
15:00	8.3	-60°F	$+100^{\circ}$F	.036
15:30	8.3	$+75^{\circ}$F	$+84^{\circ}$F	.007

NASA - [illegible] SUPPORT
W. V. [illegible]
DATA & DO[illegible] CONTROL
TASK ORD[illegible] F492
DATE 5-1-75
RELEASED BY Terry
DUPLICATE COPY

(d) Test record for polyethylene window, creep measurements.

Figure E-3.- Concluded.

Ames Research Center — April 21, 1975
University of Alaska/JPL — by phone — April 23, 1975

Integration Period Documentation

Schedule

The Mission Manager prepared a day-by-day schedule of the integration period activities giving the order of installation of experiments in the aircraft. Dates were set for the completion of various phases of the activity (see fig. E-4). The experimenter was expected to arrange his work to meet this schedule, and keep the manager informed of his progress in the daily experimenters' meeting. Schedule changes as required were by verbal agreement with the Mission Manager.

Aircraft Preparation Documents

These documents are used by Ames to prepare the aircraft for the particular mission. Roughly analogous documents will be necessary for Spacelab operations.

Aircraft Work Order- A work order is required for each aircraft-related task (design, fabrication, installation, etc.) to be accomplished by Ames or a contractor under Ames supervision. Typically, several work orders are required for each change of mission, covering removal of experiments and equipment from one mission and installation for the following one, in addition to routine aircraft servicing. The aircraft work order is a standard single-page Ames from initiated by the Mission Manager for experiment-related work, describing the task to be accomplished and authorization for that task. Sketches or formal drawings required to implement the task must be attached. An airworthiness engineer signs his approval before the work can begin; the completed work is signed off by an aircraft inspector on this same form.

Service Request- The service request is used to obtain nonaircraft-related services from Ames Support groups.

Purchase Order- The purchase order is used in acquiring equipment and supplies.

Inspection Records- An inspection record sheet (fig. E-5) is attached to each rack or other piece of equipment to be installed in the aircraft. Any deficiencies are noted by the inspector and must be worked off by the experimenter before installation activities can proceed. When installation is completed, a final inspection is made to assure conformance with all aircraft safety requirements, and an engineering checkout flight is made to verify mechanical integrity of the experiments in the flight environment. Residual deficiencies are recorded and processed as before.

EXPERIMENT OR SUPPORT SYSTEM	INSTALLATION SCHEDULE				
	APRIL		MAY		
	M T W T F S S	M T W T F S S	M T W T F S S	M T W	T
	21 22 23 24 25 26 27	28 29 30 1 2 3 4	5 6 7 8 9 10 11	12 13 14	15
MEUDON		— — L I →	E → T —	→	FINISH — CLEAN UP
GRONINGEN			L → I E T —	→	
AMES		L →	I → E →	T →	
QUEEN MARY		— — L →	I E T A —	→	
SOUTHAMPTON		— — L —	→ I E T	→	
NEW MEXICO			L → I → E →	T →	
JPL/COLORADO			L I → E A	T →	
ALASKA	L —	→ I → E	T →	A →	
NOAA		I E →	T		
EMI/ESTEC		L	E T I		
ADDAS		I	E T →	→	
50Hz CONVERTER, VACUUM PUMP			I E T		
ANALOG RECORDER, HARD COPY UNIT		I	E T →		

NOTES:
- L - LABORATORY ASSEMBLY & CHECKOUT
- I - INSTALL IN AIRCRAFT
- E - ELECTRICAL & SIGNAL CONNECTIONS
- T - TEST AND ALIGNMENT
- A - ADDAS INTERFACE

Figure E-4.- Payload integration activities.

NASA-Ames Research Center

FLIGHT TEST EQUIPMENT DISCREPANCIES

Aircraft CV 990 Rack = Serial No. 07 Date 6-3-76-

Experimenter KUTZ / WALTON

Facility MICROWAVE

Equipment DATA SYS / RADAR CONTROL Assigned Station (Aircraft)

	No.	Discrepancy	Corr. By	Date	Insp.
Tich	1	Needs I.D. Tag on rack.	Redundant		[illegible]
[illegible]	2	Hardware holding angles that support T.V. Monitor too short.	[illegible]	22 June	[illegible]
[illegible]	3.	Loose hardware in angle brackets at signal processor.	R.J.K.	6/22/76	[illegible]
[illegible]	4.	[illegible] ADDS key board unit unsatisfactory installation.	RS	6/23/76	[illegible]
	5	Support unit for key board needs 7/8" smooth notch for stabilization	RSS	6/23	[illegible]

* Final Approval - Engineer________ Date______ Inspector_______ Date______

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*Engineering changes may be approved here, but must have signed approval on Aircraft Flight Status and Maintenance Record.

Figure E-5.– Sample inspection record sheet.

Investigator and Experiment Operator Documentation

In addition to those documents implementing management functions, the PIs and EOs produced experiment specific documents. Operating procedures were prepared for each experiment, usually by the EOs working with the PIs during the integration period. It was expected that the PIs would prepare detailed operating procedures for the EOs. What actually happened was that the EOs and the PIs jointly prepared this material during the final integration and checkout period. Each set of procedures was tailored to fit the particular experiment with no attempt made to coordinate the operational procedures of the several experiments controlled by one operator. Some attention was given to maintenance and repair procedures, but not as much as the EOs would have liked. These documents are reproduced in Appendix A, The Experiment Operator.

In general, the documents in this category were prepared much later in the mission than originally intended. Analogous documentation will be even more important in Spacelab operations, and some increase in formality and more rigidity in schedule of preparation will probably be required.

Flight Period Documentation

Aircraft Operations Documents

The Mission Manager initiated various documents connected with operation of the aircraft to achieve scientific objectives. While perhaps not analogous to Spacelab requirements, they do illustrate the manager's role in the flight phase of the Mission.

Aircraft Flight Request- This form is used to notify the Flight Operations Branch of requirements for pilots and associated flight crews for a specified period. This authorization document circulates to all support groups concerned with flight preparations and operations.

Personnel Authorization to Fly- This form provides a record at Ames of the personnel authorized to fly on a given mission.

Flight Announcement- Flight announcements are posted by the Mission Manager for the information of mission participants, usually a day ahead of the flight. The announcement lists door-closing, takeoff, and landing time, and the major flight objectives.

Flight Plans- A final flight plan is drawn up daily by the navigator (in consultation with the Mission Manager) for each flight to include the latest meteorological information and science planning updates. The printout lists each leg, coordinates, and time per leg. The flight path is indicated on a map. From this plan the command pilot makes his preparations for the flight, while investigators make their detailed plans for scientific observations.

Passenger Manifest- The Mission Manager prepares this list prior to each flight and checks that only those assigned are aboard. The manifest serves as a permanent record of personnel aboard each flight.

Experiment Operations Documents

The simulation period of the NASA/ESA Joint Mission was implemented with the organization shown in figure E-6. Relatively little additional documentation was required to carry out the research activities, at least of a formal nature. Communications between participants were largely verbal and supplemented by notes and logbook entries. Although voice recordings were made of crew briefing sessions and most PI/EO conversations, there was no attempt made to provide daily transcripts. PIs interacted directly with the Mission Scientist in general planning for the next flight. The resulting consensus was relayed to the flight planner for implementation, and the final plan was reviewed with the (onboard) Mission Manager at the preflight meeting.

ADDAS printouts- Printouts of ADDAS data were made available to the investigators following each flight. One page from this record for flight 9 is reproduced in figure E-7.

Data downlink- Various forms of hardcopy were made available to the investigators just before the daily flight debriefing. Magnetic tapes, stripcharts, film records (unprocessed), X-Y plots, etc., were downlinked for preliminary evaluation (see appendix D). The type and quantity of such records was logged by the Mission Operations Manager before release.

Observation instructions- Before each flight, the PIs prepared instructions on desired timelines for operation and observation by the EOs. The operations manager kept a copy of this information in the mission log.

Mission Operations Documents

Daily activities schedule- A daily schedule was posted in the operations center to enable investigator teams and support personnel to plan their preflight preparations. The schedule was keyed to takeoff time and closely followed the sequence of events on the master plan (ref. 2, table 10).

Mission operations logbooks- As mentioned above, the Operations Manager maintained several records. A running account of events in the mission logbook provided the necessary carryover of unfinished business from shift to shift. Other records, e.g., telephone communications to or from the MOC, were primarily for ASSESS reporting needs but occasionally were used to verify mission-specific activities.

Postmission Documentation

After the conclusion of the mission, additional documentation was supplied by the Mission Manager and his staff. Shipping papers were prepared to return investigators' equipment. Analog and digital data tapes were prepared of individual experiment data streams from ADDAS records; a total of 126 reels was shipped. Atmospheric data for 16 flight days were supplied — Rawinsonde data from the National Climatic Center for numerous sites overflown; and water-vapor overburden data reduced from the measurements by the National Oceanic and Atmospheric Administration (NOAA) instrument onboard the aircraft.

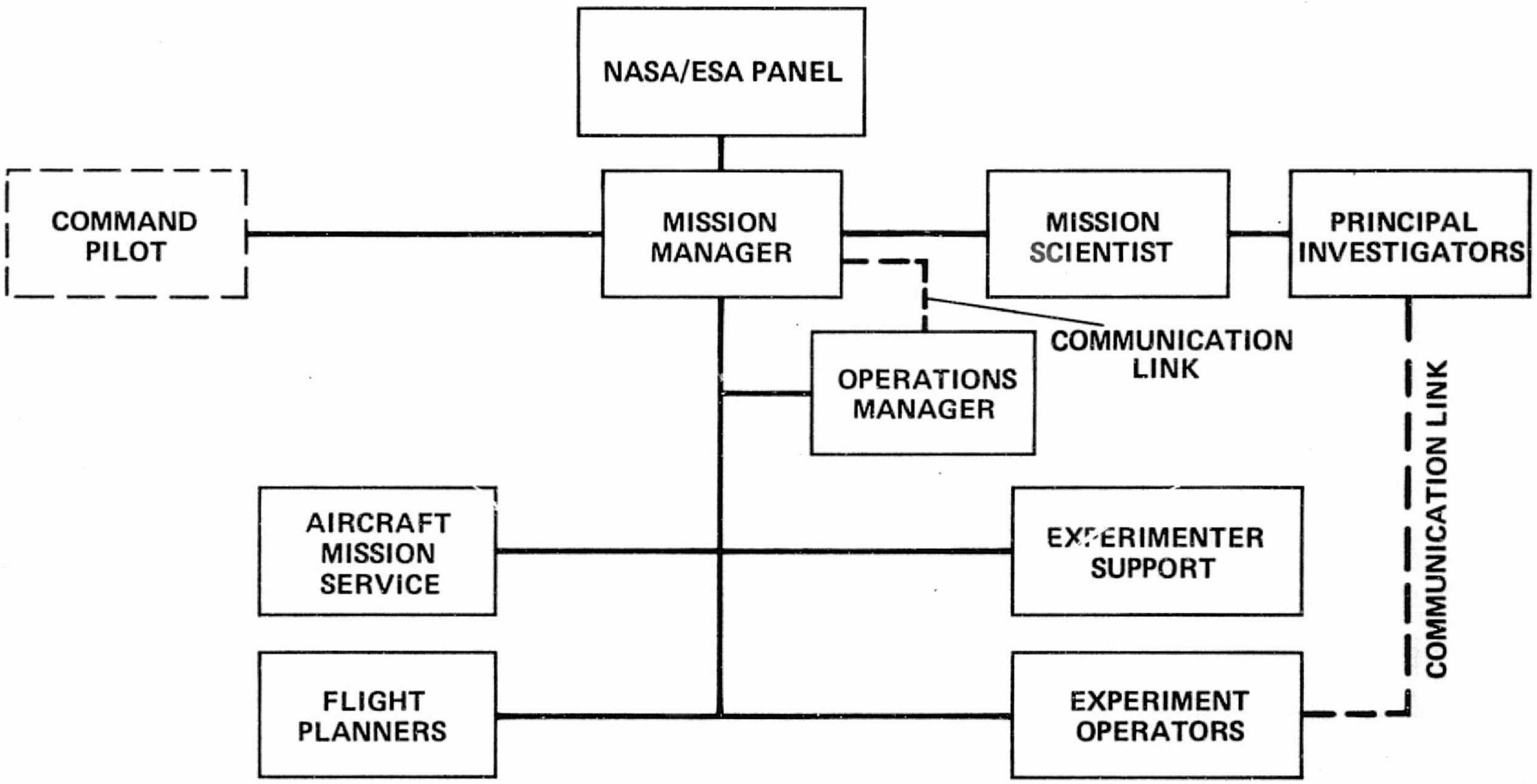

Figure E-6.- Joint Mission implementation organization for the simulation period.

JULN DATE WIND SPEED %HUM	TIME (HMS) WIND DIR H20 VAP	LATITUDE TRUE HDNG QMC SEQ	LONGITUDE DRIFT ANGL QMC T1	PRESS ALT STAT TEMP QMC T2	HI RAD ALT TOTAL TEMP QMC T3	LO RAD ALT CABIN AL	PITCH MUX VOLT	ROLL MUX CAL	IPHJ SPEED IR SF TEM	TRU AR SPD IR SAT
158	030654	3457.9	-12002.6	32930.9	31076.2	-10.5623	1.23046	-1.51611	492	494.126
005	313	183.3	-0.4	-43.5900	-13.7609	7005.61	10.0000	10.0000	[illegible]	.000000
10.0887	31.0000	1.	0.1897	6.1581	0.1423					
158	030714	3455.3	-12002.6	32944.3	32375.7	-10.2540	1.53000	2.17529	493	495.349
004	292	184.3	-0.4	-43.3484	-13.3060	7003.78	9.00512	9.00512	15.6906	.000000
10.0255	31.0549	1.	0.1897	0.1897	0.1739					
158	030734	3452.6	-12002.9	32961.7	32194.0	-10.0999	1.53000	-0.4174	493	494.666
006	306	185.6	-0.6	-45.5693	-14.1000	7003.17	8.00476	8.00476	15.4232	.000000
10.0459	31.0715	1.	0.1739	0.1897	0.1581					
158	030754	3449.8	-12003.2	32921.7	32251.2	-10.4001	1.25244	-2.10937	300	496.657
300	327	184.7	-0.4	-45.3127	-14.0470	6998.90	7.00500	7.00500	14.3047	.000000
9.72283	30.8699	1.	0.1897	0.1897	0.1423					
158	030814	3447.1	-12003.4	32913.2	32242.4	-10.2540	1.45019	.615234	490	490.136
003	323	184.3	-0.4	-43.2940	-13.4436	6990.29	6.00402	6.00402	15.5367	.000000
7.45344	29.4362	1.	0.1423	0.1423	0.1739					
158	030835	3444.2	-12003.6	33079.2	33020.0	-10.2540	2.30712	1.95556	497	497.140
005	315	185.6	-0.5	-45.3749	-14.2614	6998.90	5.00400	5.00400	15.3940	.000000
9.73104	30.9104	1.	0.1423	0.1423	0.1423					
158	030855	3441.5	-12004.0	33320.0	33414.0	-10.2540	2.20515	-1.60400	495	494.495
004	323	185.9	-0.5	-47.5145	-15.1647	7002.56	4.00695	4.00695	16.1432	.000000
12.9134	32.7418	1.	0.1423	0.1264	0.1897					
158	030915	3438.7	-12004.2	33537.2	34000.0	-10.2540	2.43896	-1.86767	493	491.566
006	318	184.9	-0.7	-45.5107	-15.9155	7004.39	3.00720	3.00720	13.8242	.000000
10.2421	31.3465	1.	0.1897	0.1739	0.1897					
158	030935	3436.0	-12004.5	33737.4	34396.9	-10.5623	2.30712	.601152	493	409.234
000	324	184.7	-0.9	-47.3240	-16.5930	7004.39	2.00603	2.00603	15.6420	.000000
12.3295	32.5671	1.	0.1423	0.1423	0.1423					
158	030955	3433.2	-12004.7	33916.9	33843.7	-10.0999	2.351077	.078986	492	407.504
012	312	186.0	-1.1	-47.7291	-17.1720	7002.56	1.00505	1.00505	15.1106	.000000
12.9398	32.9414	1.	0.1423	0.1739	0.1897					
158	031015	3430.6	-12005.0	33955.9	33621.5	-10.4001	1.29638	-2.06542	494	409.409
014	325	186.4	-1.1	-49.2603	-17.2277	7003.78	0.0067	0.0067	14.1310	.000000
16.0598	34.4545	1.	0.1897	0.1739	0.1739					
158	031035	3427.0	-12005.2	33030.0	35020.0	-10.4001	1.47216	-22.7636	30.	494.410
013	350	178.2	-0.3	-47.7504	-16.2023	6991.57	-.996093	-.996093	14.4256	.000000
13.0260	32.9610	1.	0.1423	0.1581	0.1581					

Figure E-7.- Format of ADDAS printout.

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

Postmission documentation of ADDAS software followed normal ASO procedures, with annotation of the program by the operator and preparation of flow diagrams. This information, along with the source code and paper tape record of the integrated mission software, was then available to meet requests from investigators and, in the longer term, to preserve program elements for future applications. All ADDAS master tapes were duplicated and available for loan to investigators.

Plans for the Joint Mission did not include a compilation of "first-look" scientific accomplishments by each of the investigators into a single document. An expressed need for this sort of presentation was met, in part, by a brief summary in the October 23, 1975 issue of Nature magazine (UK) (ref. 3). Inputs to this article were coordinated by the ESA representative on the MPG. For the Spacelab era, a more formal document that presents an integrated summary of mission science results should be considered.

One additional document, an ESA/ESTEC test report on EMI measurements, has been released (ref. 4). Although this report is perhaps not a mission document, in the usual sense, its 556 pages present much information of use to both airborne and Spacelab mission planners.

ASSESS OBSERVATION DOCUMENTATION

The ASSESS Observer Team of six engineers and scientists assembled a large data bank for the Joint Mission. The collection includes all but a few of the documents mentioned in this appendix, extensive notes on the events day-by-day during the active portion of the mission, notes on interviews with the PIs and EOs, notes by the EOs which include suggestions for future Spacelab operations, and the transcription of the lengthy debriefing held immediately following the simulation period. This data bank was not necessary for the actual performance of the mission, but it has been the principal source of information for the Joint Mission reports.

CONCLUDING REMARKS

The Joint NASA/ESA CV-990 ASSESS Mission demonstrated the adaptation of normal ASO management methods to the development and operation of a Spacelab-like payload of atmospheric physics and astronomy experiments from both U.S. and European sources. The two fundamental principles of the ASO approach — management control by one person, the Mission Manager, and investigator responsibility for the experiments in all phases of the mission — were mission baselines that were followed except when necessary to exercise local control during the preparation of ESA-funded experiments and to implement the training of proxy experiment operators.

Similarly, documentation for the Joint Mission followed normal ASO practice as a baseline, with added formality where indicated to achieve mission research goals. Whenever possible, the Mission Manager, backed by experienced support personnel, used verbal communication and single-page documents to conduct mission business. Normal planning procedures required various documents — investigator requirements, equipment and interface definition, safety approvals, mission schedules, flight plans, experimenters' bulletins, etc. These were augmented by a Mission Operating Plan, a formalized Experiment Readiness Review, operator training plans, and experiment operating procedures. Even so, the quantity and depth of required documentation were relatively modest and in keeping with the stated mission approach.

The airborne science analogy to Spacelab is one of common purpose, closely related functional elements, and comparable time schedules. To the extent that a focused mission management can interact directly with users, that the responsibility for an experiment can be retained by the investigator, and that the role of the experiment operator is fully developed, the formal documents required for a Spacelab mission should be prevented from expanding significantly beyond those described for the Joint Mission.

REFERENCES

1. NASA/ESA CV-990 Spacelab Simulation, Executive Summary. NASA TM X-62,457 and ESA-SL-75-1, 1975.

2. Reller, John O., Jr.: NASA/ESA CV-990 Spacelab Simulation, Final Report. NASA TM X-73,105 and ESA-SL-75-2, 1976.

3. Nature. Simulation experiments for Spacelab. Vol. 237, pp. 649-651, Oct. 23, 1975.

4. Bachmann, H. and Steintz, J. A.: EMI Test Report, ASSESS Mission 1975. ESA/ESTEC TTA/76/2255, Jan. 9, 1976.

ATTACHMENTS

Mission Operating Plan — January 1975 revision

Experimenters' Bulletins — March 25, 1975 and April 14, 1975

CV-990

NASA/ESRO ASSESS MISSION

MISSION OPERATING PLAN

Prepared by L. C. Haughney

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Revised
January 1975

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INTRODUCTION

Spacelab is a major element of the Space Shuttle system being developed to transport people and equipment on a routine basis between ground and Earth orbit. The Shuttle concept substantially reduces costs of space operations by repetitive use of most of its major components. It also saves money for the experimenter over unmanned systems because his instrumentation and equipment can be returned to Earth for reuse or repair rather than be abandoned in orbit. Further cost savings over previous manned experiment missions will be possible by streamlining the operational approach to placing and using experiments in orbit.

Spacelab will have facilities and equipment similar to laboratories on the ground. It will provide a shirt-sleeve environment for a small group of experimenters. Up to four researchers may staff a Spacelab mission. Throughout the missions Spacelab will remain attached to the Shuttle Orbiter, where the research personnel will eat and sleep. Because of the limited accommodations available for people onboard the Spacelab, there will be more experiments than research personnel, and it will be necessary that each person operate more than one experiment. Thus, the personnel operating the experiments may be proxy operators for the principal investigators.

The plan to conduct experiments on Spacelab resembles, in many ways, the highly successful program developed by the Airborne Science Office (ASO) at NASA/Ames Research Center during the past nine years. Since the inception of Spacelab planning, the analogy of the Airborne Science program to the Shuttle Spacelab on sortie missions has received increasing attention. In July 1972 a special program was initiated at Ames to identify and expose details of the Airborne Science experiments-management approach that may be applicable to the Spacelab program.

This study program, called ASSESS (Airborne Science/Shuttle Experiments System Simulation), is divided into two phases. Phase A is a study of ongoing airborne missions to identify and analyze elements that are relevant to the Spacelab program. Phase B is devoted to an evaluation of selected airborne missions constrained to simulate Shuttle Spacelab operations for a continuous five-day period. These simulation missions consist of authentic research projects conducted by qualified experimenters. To date, five simulation missions have been conducted, four with the ASO Lear Jet and one with the CV-990 aircraft.

As a continuation of Phase B of the ASSESS program, the next Spacelab simulation mission with the CV-990 aircraft will be conducted by ASO to study special features of Spacelab missions. This simulation mission will be a joint effort between NASA and ESRO. Each agency will be responsible for selecting and funding a group of compatible experiments. The experiments will be operated during the simulation period by experiment operators (E.O.'s) who will be trained by the scientific investigators. Two E.O.'s will be selected by each agency to operate the experiments. A mission manager will be appointed from the staff of the Airborne Science Office to coordinate the mission. A Mission Planning Group (MPG) composed of members from ESRO Headquarters, NASA Headquarters, NASA/Marshall Space Flight Center, NASA/Johnson Space Center, and NASA/Ames Research Center has been formed to establish policy and guidance for the mission.

The ASSESS study will encompass activities of the mission manager, investigators, and experiment operators; the experiment design, preparation, and performance; and all phases of mission management and operations.

OBJECTIVES

During a series of preliminary discussions prior to formation of the Mission Planning Group, the objectives of a cooperative mission with the CV-990 aircraft were proposed and subsequently adopted by the MPG. These are as follows:

1. Determination of optimum design approaches for experiments to be operated in Spacelab, in terms of experiment methodology and actual design of instrumentation.

2. Evaluation of payload and mission operations, including crew interactions, for Spacelab.

3. Determination of impact of operational requirements and procedures on Spacelab subsystem design and orbiter-Spacelab interfaces.

4. The determination of procedures suitable for training of payload operators, particularly in proxy experiment operations.

In addition, information will be obtained on planning and operational requirements for an international mission involving two major agencies (ESRO and NASA), and preparation and operation of a shared European/U.S. experiment arrangement.

MISSION GUIDELINES

The Mission Planning Group for this mission has established guidelines for the mission that will both satisfy the requirements of existing programs and comply with the conditions of Spacelab constraints. The guidelines for this mission are as follows:

1. The experiment preparation, installation, and check-out will be conducted in accordance with standard ASO operation; i.e., the investigator will have prime responsibility for most aspects of the experiment preparation and integration.

2. During the simulation period, the experiments will be operated by experiment operators. Provision will be made for daily interaction between the experiment operators and the investigators through voice and video communication links.

3. The simulation period will last five flight days. This will be followed by a 10-day unconstrained flight period to allow the investigators to complete their scientific measurements.

4. Unconstrained pre-simulation flights will be arranged to represent pre-flight check-out in the Spacelab simulator.

5. Authentic scientific measurements will be performed.

6. The mission manager and experiment operators will be confined to the airplane for the duration of the simulation period. Living accommodations will be provided adjacent to the airplane.

7. To stress the operation of the experiments as much as possible, one six-hour flight will be scheduled for each of the five days during the simulation period.

8. Spare experiment components and subassemblies considered necessary by the investigators to ensure the success of the mission will be permitted on board for the simulation period. Test equipment and tools will be limited to justified needs. An attempt will be made to pool items common to several experiments to minimize the quantity of test equipment and tools taken on board.

9. A mission coordination center will be employed during the simulation period. No direct personal contact with the mission manager and experiment operators from people outside the ASSESS management, operations, and observation groups will be permitted. Voice and video communication between the aircraft and the mission coordination center will be provided between flights. All communications outside the ASSESS complex will be by telephone, which will be installed in the aircraft between flights.

10. All support equipment furnished by ASO will be maintained by non-confined personnel.

11. Non-confined ASSESS observers will be stationed on board the aircraft at all times except during sleeping periods.

12. Experiment hardware will be consolidated on the aircraft to the extent possible to permit the most efficient experiment operator performance consistent with the same objective contemplated for Spacelab.

13. ASSESS experiment operator timeline activities will be constrained to the extent possible consistent with the expected Spacelab experiment operator timelines.

14. Certain experiment support systems on the aircraft not feasible to automate for this mission will be operated by personnel on board and will be considered as automated systems during the simulation period.

ORGANIZATION AND FUNCTIONS

Management

Mission Manager. - The scientific research for this mission will be managed, for the most part, in the manner normally followed in ASO for the ongoing CV-990 program. The ASO mission manager is responsible for all aspects of the mission, and he serves as the mission director. He and his staff are the single points of contact for the investigators in installation and check-out of the experimental apparatus. He will direct the flights and act as coordinator between the experiment operators and other personnel as required. During periods on the ground, all outside contacts with the experiment operators will be by telephone or a separate voice and video link through the mission manager.

Mission Coordination. - A mission coordination center will be established by the Airborne Science Office and will provide a point of contact and coordination for the mission during the simulation period. The investigators may use the center to direct the activities of the experiment operators on a daily basis.

Daily flight planning will be arranged by communication among the navigator/ flight planner and investigators located in the mission coordination center and the mission manager in the aircraft.

All communications between the aircraft and Ames Research Center personnel during the simulation period must be conducted through the mission coordination center and with the cognizance of the mission manager.

Investigators

The investigators will be responsible for the following:

1. Development of scientific objectives.

2. Design and preparation of experiments.

3. Development and implementation of training plan for E.O.'s.

Experiment Operators (E.O.'s)

During the simulation period, the E.O.'s will have responsibility for the following:

1. Operation, maintenance, and repair of all experiments within their purview.

2. Preliminary processing of data.

3. Communicating to investigators all pertinent information regarding experiment performance.

Flight Crew

The pilots will be provided by the Flight Operations Branch of Ames Research Center. The Navigator/flight planner will be provided by the Airborne Science Office.

Observers

To provide ASSESS data for possible application to Spacelab planning, observations will be required of all pertinent activities of the investigators and experiment operators during experiment preparation, experiment operator training, and scientific data acquisition. The observations will be made by assigned observers. At all times, the observations are to impose minimal disruption to the activities being observed.

Observation of ESRO Experiments. - The ESRO experiment operators have been assigned to act as observers for the ESRO experiments during the periods of experiment preparation and E.O. training.

Observation of U.S. Experiments. - A team of observers will periodically review the preparation of U.S. experiments at the various investigators' laboratories. As experiment operator training develops, these activities will also be observed.

Observations During Simulation Period. - During the Spacelab simulation period, an observer will be stationed on board the aircraft at all times except during sleeping periods. His function will be to make direct observations of all work activities of the mission manager and experiment operators for both ESRO and U.S. experiments. The observer will not be confined.

Another observer will observe and document the activities of the personnel in the mission coordination center.

Support Personnel

Support for the mission will be provided by a number of groups at Ames Research Center. Installation of the experiments in the airplane will be done primarily by the Metals Fabrication Branch. The work will be monitored by the Aircraft Inspection Branch and the Airworthiness Assurance Office. Supplies and equipment will be provided by ASO laboratory personnel.

During the simulation flights, the ASO flight planners, the Flight Operations Branch, the Aircraft Services Branch, and the Aircraft Inspection Branch will all provide support for the mission. Special personnel will be assigned by ASO to operate experiment-support systems that will be regarded as automated for the ASSESS flights. These personnel will not be confined.

SCHEDULE

The schedule of activities for the entire mission is shown in Table I. Updating of the schedule will be accomplished through Experimenters' Bulletins, which will be issued as required.

	MILESTONES	1974 JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
1	Investigator's familiarization meeting at ARC.	6						
2	Preliminary sketches and descriptions of experiments due in ASO.		12					
3	Preliminary schedule and mission plan completed.			30				
4	MPG meeting #3 at NASA Headquarters-U.S. experiments selected-Experiment Operators (EO) selected				12			
5	Design of escape hatch modification for telescope mounting completed				30			
6	Project management review at ARC.					10		
7	Experiment racks shipped to investigators.					(16-31)		
8	Familiarization meeting at ARC for U.S. investigators.					18		
9	E.O. training begins at P.I. laboratories.						11	
10	NASA funding to U.S. investigators.						13	
11	Revised schedule and mission plan completed.						14	
12	Mission Planning Group meeting #4 at ESRO Headquarters, Paris.						19	
13	Meeting of all investigators and E.O.'s at ESRO Headquarters, Paris.						20	
14	Investigators submit detailed sketches of experiments and stress analyses to ASO.							2
15	Investigators submit training plans, evaluation criteria, and milestone charts.							13
16	Meudon test cavity and telescope mounting plate installed on CV-990.							16
17	Flight test of telescope cavity with aerodynamic fence.							20
18	Investigators submit preliminary ADDAS software requirements to ASO.							3

NOTES:

TABLE I

SCHEDULE FOR NASA/ESRO CV-990 ASSESS MISSION

	MILESTONES	1975 JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY
19	Investigators submit final ADDAS software requirements to ASO.		14					
20	Investigators submit list of ASO-supplied support equipment required for experiments to ASO.		17					
21	Project management review at ARC.		17					
22	Mission Planning Group Meeting #5 at ARC.		19					
23	FRR for U.S. experiments and preliminary FRR for U.S. E.O.'s at ARC.			25				
24	FRR for ESRO experiments and preliminary FRR for ESRO E.O.'s at ESRO Headquarters.				1			
25	Shipment of experiments to ARC.				21–2			
26	Investigators' selection of targets and lists of tools, spare parts, & test equipment at ASO.				29			
27	Project management review at ARC.				30			
28	Installation of experiments and ASSESS support equipment in aircraft & ground check-out in a/c.				30–15			
29	Aircraft maintenance and pilot proficiency flights--aircraft not available to investigators					(19–20)		
30	Ground training of E.O.'s in aircraft.					(20–28)		
31	Mission planning meeting for investigators and E.O.'s at ARC.					20		
32	Safety briefing for all flight participants at ARC.					20		
33	Mission Planning Group Meeting #6 at ARC.					21		
34	Experiment flights (2).					(21–23)		
35	Experiment flight (1).					29		
36	Mission FRR for experiments & E.O.'s. Final mission briefing for investigators & E.O.'s.					30		
37	Simulation mission--mission manager and E.O.'s confined to aircraft. 5 flights						(2–6)	

NOTES:

	MILESTONES	1975 JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
38	Debriefing for simulation phase.	7						
39	Experiment flights under normal ASO operating conditions (6 - 8 flights).	(9-20)						
40	Debriefing for entire mission.	21						
41	Final Mission Planning Group Meeting.	23						
42	Remove experiments from aircraft.	(23-24)						

NOTES:

RESEARCH EXPERIMENTS

General Nature of Experiments

The mission will be a nighttime mission since the experiments are being chosen in the areas of astronomy and upper atmospheric nightglow emissions. In particular, the emphasis will be on infrared and near ultraviolet observations which become feasible at the airplane's altitude of 12 km (40,000 ft.) and on experiments which require geographical mobility in a short time (such as latitude surveys).

In addition to the usual criteria for selecting airborne science experiments, another consideration is the possible contribution of the experiment to the planners of the Spacelab.

Description of Experiments

The ESRO experiments are listed in Table II. The U.S. experiments are listed in Table III. Short descriptions of each experiment follow.

TABLE II

ESRO EXPERIMENTS FOR CV-990 NASA/ESRO ASSESS MISSION

NO.	INSTRUMENTATION	MEASUREMENT	
E 1	∘ 30-CM F/7.2 CASSEGRAIN TELESCOPE ∘ 4-CHANNEL IR RADIOMETER ∘ GE BOLOMETER, LHE COOLED	HIGH-RESOLUTION MAPPING OF DARK CLOUDS AND HII REGIONS	(EU 6)
E 2	∘ POLARIZING INTERFEROMETER ∘ GE BOLOMETER, LHE COOLED	EMISSION SPECTRA OF UPPER ATMOSPHERE	(EU 4)
E 3	∘ IMAGING ISOCON TV CAMERA	OBSERVATION OF OH AIRGLOW CLOUDS	(EU 3)

ASSESS Program
Airborne Science Office
NASA Ames Research Center
7/16/74

TABLE III. U.S. EXPERIMENTS FOR CV-990 NASA/ESRO MISSION

NO.	INSTRUMENTATION	MEASUREMENT
US 1	Continuously variable, filter-wedge spectrometer Ga:Ge detector, LHe cooled (To share telescope of E1 experiment)	Near IR spectral measurements (4 to 24μm) of solar system objects and late type stars.
US 2	12.5-cm Ebert-Fastie spectrometer 1-meter Ebert-Fastie spectrometer Tunable acousto-optical filter spectrometer	Near UV (2900-4000A) observations of planetary atmospheres, solar system bodies, and stellar objects.
US 3	Image intensifier, system with filters, 35-mm camera 16-mm camera with image tube and wideband filter for time-lapse photography Photoelectric photometer and interference filters	Photography of IR airglow structure and temporal variation, 7000 to 9000A.

Experiment E1 (EU 6)

Scientific Discipline -	IR Astronomy
Scientific Objectives -	High-resolution mapping of dark clouds and H II regions.
Principal Investigators -	
	Observatoire de Meudon (France)
	CNRS-Verrières (France)
	University of Groningen (The Netherlands)
Primary Instrumentation -	4-Channel IR photometer mounted on 30-cm Cassegrain telescope
Observational Bandwidths -	17-20μm, 30-38μm, 70-95μm, and 114-196μm

General Description

This is a basic scientific experiment designed for further understanding of early star formation from dark clouds of material which are strong IR emitters. The cloud near the star ρ Ophiuchus is an excellent subject for further study because of its relative closeness and low temperature.

The experiment utilizes the Meudon telescope and the Groningen photometer. The photometer selects one of the four wave bands noted above and uses a 2.4°K germanium bolometer as the detector. The signal is amplified and synchronously detected by conventional electronic circuitry. The data record is on digital tape.

The Meudon telescope has been flown extensively on a French Caravelle research aircraft. The open-port telescope is gyrostabilized to an accuracy of 15 arc seconds attainable by complex data processing. A TV camera and monitor are used for finding and tracking.

Experiment E2 (EU 4)

Scientific Discipline - Atmospheric Physics

Scientific Objectives - Emission Spectrum of the upper atmosphere.

Principal Investigator -

Queen Mary College
University of London, England

Primary Instrumentation - Polarizing Interferometer (including internal temperature references)

Observational Bandwidth - 40μm - 2mm

General Description

This experiment measures the emission spectrum of the upper atmosphere over a wide range. The measurements are absolute and relate to concentrations and temperatures of the various molecular components.

The instrumentation is a two-beam interferometer based upon polarizing optics. The two signals which are compared are the atmospheric emission and the calibration source (alternately liquid nitrogen and ice). A rotating polarizer is used as a chopper to produce positive and negative interferograms. The spectrum is the Fourier transform of the interferogram. A 2°K germanium bolometer is used as the detector.

Aircraft data system signals will be used in the stabilization of the optical path. The amplified and detected data signals will be digitized and recorded on the aircraft ADDAS equipment.

Experiment E3 (EU 3)

Scientific Discipline -	Atmospheric Physics (airglow)
Scientific Objectives -	Observation of OH airglow clouds to determine wind velocities at altitudes between 85 and 110 km.
Principal Investigator -	
	University of Southampton, England
Primary Instrumentation -	Image Isocon TV camera system
Observational Bandwidth -	650-950nm (near IR)

General Description

This experiment is planned to measure motion of OH airglow clouds for an extended period of time, far more than that achieved from chemical trails released from sounding rockets. Such information will aid in filling a large gap in present models of global winds.

The instrumentation consists of an image Isocon TV camera, its control circuitry, and a recorder. The photocathode of this camera cuts off at about 950nm and a filter will be used to cut off energy shorter than 650nm. The electronic circuitry of the camera system has been modified to permit integration of the signal by reducing the picture rate. Integration times up to two minutes are planned. The integrated pictures are read out during a normal TV scan and recorded on a video recorder. A crystal-controlled 50-Hz power supply will be provided to maintain European TV standards of 1/50 sec scan time and 625 lines.

The data will be coordinated with the record from an all-sky camera utilizing IR film and exposures of 5 to 10 minutes. This camera is provided as part of the experiment.

Experiment US 1

Scientific Discipline -	IR Astronomy
Scientific Objectives -	Spectra of Venus and late type stars.
Principal Investigator -	
	NASA, Ames Research Center
Primary Instrumentation -	Filter wedge spectrometer mounted on 30-cm Cassegrain telescope
Observational Bandwidths -	1-4μm and 3-6μm

General Description

This experiment is designed to obtain spectral information of Venus and late type stars. Of primary interest will be observations of sulfuric acid absorption in the atmosphere of Venus.

The experiment utilizes an existing filter wedge spectrometer. A gallium doped germanium bolometer will be used, cooled to liquid helium temperature. The experiment will be mounted on the Meudon telescope in place of the Groningen photometer. Signal processing circuitry will be supplied by the Ames group. (See Experiment El for details of these portions of the equipment.) This experiment represents an interesting shared use of an experimental facility.

Experiment US 2

Scientific Disciplines -	Atmospheric Physics and UV Astronomy
Scientific Objectives -	UV measurements of atmospheric transparency, solar flux, planetary atmospheres, and interstellar molecules.
Principal Investigator -	
Co-investigators -	
	Geophysical Institute, University of Alaska
Primary Instrumentation -	12.5-cm Ebert-Fastie UV Spectrometer 1-m Ebert-Fastie Spectrometer Tunable acousto-optical filter spectrometer
Observational Bandwidths -	2900-4000 Å

General Description

The experiment will measure UV radiation from several sources. Solar flux will be measured between 2900 and 4000 Å with a special note of the erythemal flux between 3000 and 3200 Å. Atmospheric UV transparency will be measured at 14 km altitude. Planetary emissions will be noted in several narrow bands.

Two Ebert-Fastie spectrometers of differing size will be used, 12.5-cm and 1-m. The smaller one is the laboratory prototype of the Pioneer Venus Orbiter spectrometer. This device is controlled entirely by digital signals. The larger one can be set to scan any of a number of preselected bands by interchanging cams in the scanning mechanism. Gyrostabilized mirrors will be provided in the optical paths.

The acousto-optical spectrometer is a new device capable of rapid scanning of the optical spectrum. No cryogenic cooling is required for these instruments, although thermoelectric cooling is used in the 1-m spectrometer.

Data will be recorded on digital tape and the aircraft ADDAS equipment.

Experiment US 3

Scientific Discipline -	Atmospheric Physics
Scientific Objectives -	Photography of infrared airglow.
Principal Investigators -	
	University of New Mexico
Primary Instrumentation -	35-mm camera with IR image intensifier, 16-mm camera with IR image intensifier for time-lapse photography, IR photometer for calibration
Observational Bandwidths -	6500-9000 Å

General Description

This experiment will study infrared OH airglow clouds near the horizon, using wide-band photography of large areas of the sky and narrow-band photometry of the center of the area photographed.

Both cameras will be equipped with image intensifier tubes to permit exposure times of the order of seconds, using wide bandpass filters covering 7000-9000 Å. The red-sensitive photomultiplier will record airglow intensities through eight filters: three narrow-band filters centered on individual airglow bands; three narrow-band filters centered between airglow bands to record background; one opaque filter and one wide bandpass filter identical to those used on the cameras for absolute calibration. The 16-mm cameras will make time-lapse exposures, producing motion pictures of the changing airglow structures.

All data will be on film and strip chart recorder; no use will be made of the aircraft systems for data except to obtain a time record of the aircraft track.

Experiment Design

Operation of several experiments by an experiment operator during a single flight may be required. Accordingly, it is expected that the investigators will incorporate modifications to their existing experiment designs to facilitate optimum multi-experiment operation.

The investigator will design and construct his experiment to meet the program requirements and guidelines within the airworthiness and safety considerations given in the CV-990 Experimenters' Handbook. Frequent contact with the mission manager for guidance in this regard is recommended.

PHYSICAL ARRANGEMENT

Aircraft and Auxiliary Equipment

The CV-990 aircraft, which will serve as both a flying laboratory and the work area for the experiment operators and mission manager, will be docked during periods on the ground on the main hangar apron in an area near the mission coordination center. Living quarters will be located in a mobile lift van that can be positioned adjacent to the rear cabin door of the CV-990 aircraft. The van will contain sleeping, dining, and shower facilities. It will have a separate air conditioner. Air conditioning for the aircraft cabin will be provided by a self-powered ground unit.

Auxiliary ground units will provide 60-Hz and 400-Hz electrical power and compressed air to the aircraft for use by the experiment operators between flights.

Two telephones with two communication lines will be provided in the airplane during ground periods for the constrained personnel. One of the telephones will be fitted with a speaker-phone. A one-way video-audio system with recording capability will be set up between the aircraft and the mission coordination center to provide personnel in the mission coordination center with the capability of viewing experiment components on the aircraft to aid the investigators in directing experiment maintenance, repair, and data analysis.

The intercom system between the mission manager and the pilots, navigator, and the experiment operators will be connected to a tape recorder to record conversations of interest to the ASSESS mission during flight. A time-code generator will provide a time reference signal on one channel of the tape.

Aircraft Interior

Arrangement of the experiments and auxiliary equipment in the airplane is shown in Figure 1.

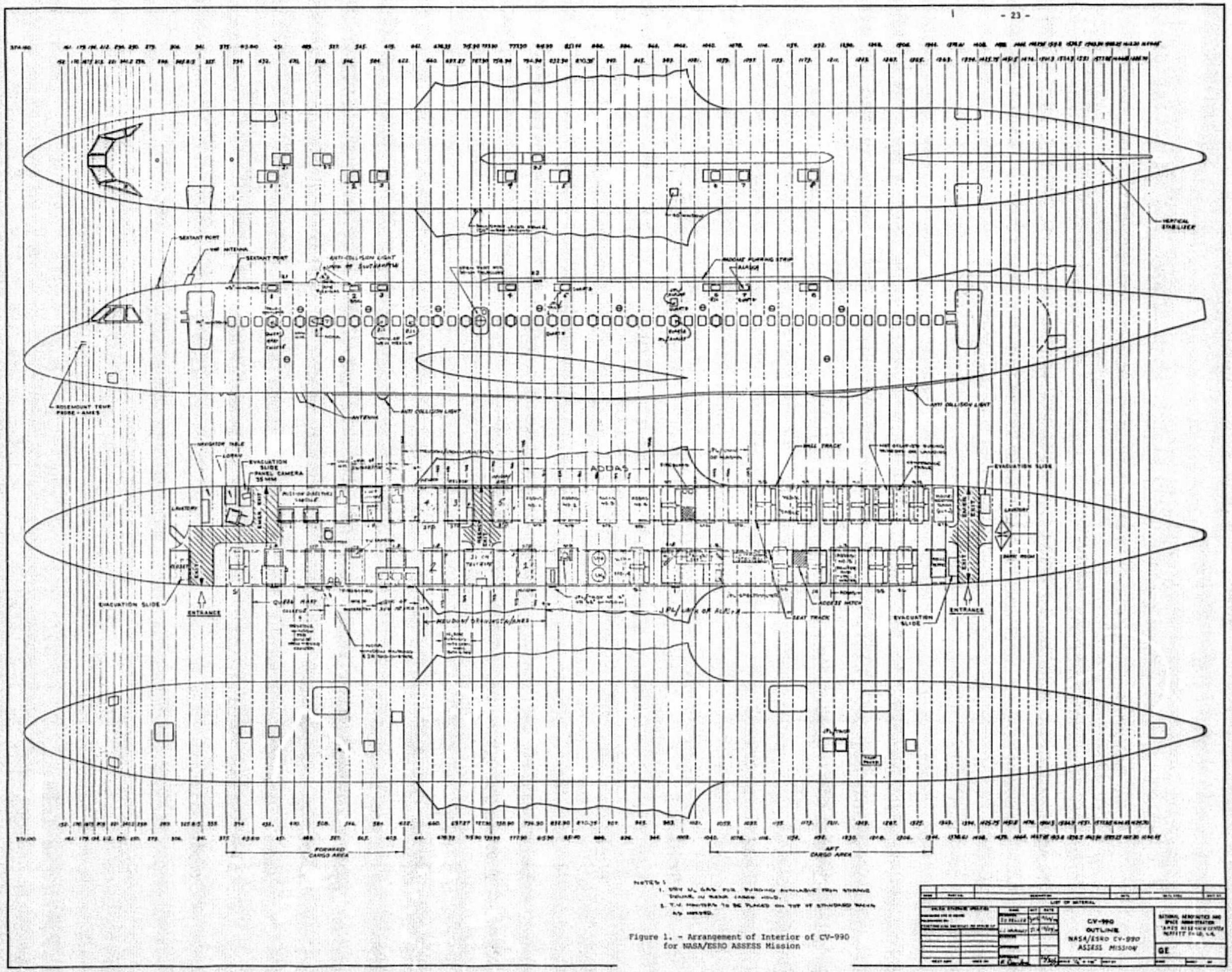

Figure 1.- Arrangement of Interior of CV-990 for NASA/ESRO ASSESS Mission.

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SUPPORT ITEMS FOR EXPERIMENTERS

A mission guideline has been established that allows the investigator to bring on board any type of spare subassemblies, components, or tools considered necessary to ensure the success of his experiment. However, test equipment and tools will be limited to those that can be justified by each investigator and can be accommodated on the aircraft. Lists of all such equipment will be prepared by each investigator.

Once the mission is started, the Airborne Science Office will supply and document any additional test equipment or parts that are required to avoid jeopardizing the success of the mission.

Test Equipment

Test equipment will consist primarily of general purpose diagnostic devices for troubleshooting electronic circuits. These will be standard laboratory-type devices for use in the onboard work area. Circuit diagrams for investigator-built equipment and service manuals for commercial units will be supplied by the investigator, while the ASO will supply reference documents for any ASO-supplied equipment.

Spare Parts

Each investigator must include with his experiment an adequate supply of back-up components critical to the continued operation of his experiment. Spare components might include such items as photomultiplier tubes, voltage-controlled oscillators, amplifiers, power supplies, or printed circuit modules.

Tools

The investigators will furnish their own hand tools, soldering irons, and any special devices that are required to maintain their experiment. ASO will furnish a limited number of aircraft-peculiar tools (e.g., air-driven drill motor) that are not normally in the investigator's laboratory.

Supplies

The investigators will furnish a variety of supplies, mostly in small quantities, to support the program. These will be supplemented by cryogenics and other supplies provided by the Airborne Science Office. Specifically, dry ice, gaseous nitrogen, liquid nitrogen, and liquid helium, as required by the investigators, will be provided by ASO.

EXPERIMENT DATA ACQUISITION AND PROCESSING

The CV-990 Experimenters' Handbook contains pertinent information on the capabilities and input requirements for the Airborne Digital Data Acquisition System (ADDAS). Further information is contained in NASA TMX-62,367, entitled, "Interactive Data Management Systems for Airborne Research". Refer to Table I, Schedule for NASA/ESRO CV-990 ASSESS Mission, for deadlines on submission of ADDAS software requirements to ASO.

OPERATIONS PLAN

Flight Plans

The flight plans will be determined mostly by the astronomical objects which experiments E 1 (Meudon-Groningen), US 1 (Ames), and US 2 (JPL/Alaska) wish to observe. These objects are listed in Table IV. Astronomical flights tend to be along east to west routes so as to observe the celestial object around its transit. Then the rates of change of elevation and azimuth angles are at a minimum compared to the times when the object is in the rising or the setting part of its journey across the sky. A sample flight plan is attached (Fig. 2a); this plan allows E 1 to observe the star ρ Ophiuci, its first priority object, for one and a half hours, during which time the star moves through an elevation range of only 0.5° and remains at the same bearing relative to the airplane. The ASO flight planners use a computer program (Fig. 2b) that gives the flight path needed to keep the celestial object within the field of view for as long as it is possible.

TABLE IV. - OBSERVATIONAL OBJECTS

I. MEUDON-GRONINGEN

Priority	Object	R.A.	Dec.	L.T. Transit June 11-12	Latitude for 33° Elev. at Transit
1	ρ Oph	16h 24m	-23° 04'	23 04	33° 56'
2	M 17	18h 17m	-16° 11'	00 57	40° 49'
3	M 8	18h 00m	-24° 20'	00 40	32° 40'
4	B 68	17h 21m	-23° 48'	00 01	33° 12'
4	B 92	18h 19m	-18° 16'	00 54	38° 44'
4	B 133	19h 04m	- 6° 57'	01 44	50° 03'
4	B 335	19h 35m	7° 31'	02 12	64° 31'
5	Tau Cloud	4h 32m	26° 02'	11 10	83° 02'
6	N.A. Neb.	20h 50m	43° 00'	03 29	?
7	M 42	5h 32m	- 5° 25'	12h10	51° 35'

II. AMES-JPL

Object	R.A.	Dec.	L.T. Transit June 11-12	Latitude for 33° Elev. at Transit
Venus	8h 34m	21° 03'	15h 11m	78° 03'
Jupiter	1h 11m	6° 13'	07h 50m	63° 13'
Mars	1h 02m	4° 48'	07h 42m	61° 48'
Saturn	7h 19m	22° 06'	13h 57m	79° 06'
R Leonid	9h 45m	11° 40'	16h 21m	68° 40'
α Her	17h 12m	14° 27'	23h 57m	71° 27'
α Scor	16h 26m	-26° 19'	23h 06m	30° 41'
β Hydri	11h 50m	-33° 38'	18h 31m	23° 22'
α Boötes	14h 13m	19° 27'	20h 50m	76° 27'

Figure 2(a).- Sample Flight Plan.

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Figure 2(b). - Computer Printout for Flight Plan

R OPH CV990 JUN 12 1975 300/55

ALTITUDE= 39000.0 FEET
SPEED= 470.0 KNOTS

UT	AIRCRAFT HEADING	LATITUDE	LONGITUDE	OBJECT ELEV	OBJECT AZ	REL BEARING
5 30 0	272.464	N 35 .0	W 96 .0	31.932	180.464	268.000
5 35 0	273.046	N 34 59.2	W 96 42.8	31.939	181.046	268.000
5 40 0	273.633	N 34 58.9	W 97 25.6	31.935	181.633	268.000
5 45 0	274.220	N 34 58.9	W 98 8.3	31.919	182.220	268.000
5 50 0	274.806	N 34 59.3	W 98 51.0	31.893	182.806	268.000
5 55 0	275.392	N 35 .1	W 99 33.7	31.855	183.392	268.000
6 0 0	275.979	N 35 1.4	W 100 16.3	31.806	183.979	268.000
6 5 0	276.564	N 35 3.0	W 100 58.9	31.746	184.564	268.000
6 10 0	277.148	N 35 5.0	W 101 41.5	31.675	185.148	268.000
6 15 0	277.732	N 35 7.4	W 102 24.1	31.592	185.732	268.000
6 20 0	278.315	N 35 10.2	W 103 6.6	31.499	186.315	268.000
6 25 0	278.897	N 35 13.4	W 103 49.0	31.395	186.897	268.000
6 30 0	279.477	N 35 17.0	W 104 31.4	31.280	187.477	268.000
6 35 0	280.056	N 35 21.0	W 105 13.8	31.153	188.056	268.000
6 40 0	280.634	N 35 25.4	W 105 56.2	31.016	188.634	268.000
6 45 0	281.209	N 35 30.2	W 106 38.4	30.869	189.209	268.000
6 50 0	281.783	N 35 35.3	W 107 20.7	30.710	189.783	268.000
6 55 0	282.354	N 35 40.8	W 108 2.9	30.541	190.354	268.000
7 0 0	282.924	N 35 46.7	W 108 45.0	30.362	190.924	268.000
7 5 0	283.491	N 35 53.0	W 109 27.1	30.172	191.491	268.000
7 10 0	284.056	N 35 59.7	W 110 9.2	29.972	192.056	268.000
7 15 0	284.618	N 36 6.7	W 110 51.2	29.762	192.618	268.000
7 20 0	285.178	N 36 14.1	W 111 33.1	29.542	193.178	268.000
7 25 0	285.735	N 36 21.9	W 112 15.0	29.311	193.735	268.000
7 30 0	286.290	N 36 30.1	W 112 56.8	29.071	194.290	268.000

M17 CV990 JUN 12 1975 245/50

ALTITUDE= 39000.0 FEET
SPEED= 470.0 KNOTS

UT	AIRCRAFT HEADING	LATITUDE	LONGITUDE	OBJECT ELEV	OBJECT AZ	REL BEARING
7 0 0	250.65[illegible]	N 35 46.7	W 108 45.0	35.310	158.659	268.000
7 5 0	251.2[illegible]	N 35 35.4	W 109 25.6	35.654	159.258	268.000
7 10 0	251.862	N 35 24.5	W 110 6.4	35.988	159.862	268.000
7 15 0	252.472	N 35 13.9	W 110 47.2	36.312	160.472	268.000
7 20 0	253.087	N 35 3.8	W 111 28.0	36.626	161.087	268.000
7 25 0	253.708	N 34 54.0	W 112 8.9	36.929	161.708	268.000
7 30 0	254.333	N 34 44.7	W 112 49.9	37.221	162.333	268.000
7 35 0	254.964	N 34 35.8	W 113 31.0	37.503	162.964	268.000
7 40 0	255.600	N 34 27.3	W 114 12.2	37.773	163.600	268.000
7 45 0	256.241	N 34 19.2	W 114 53.4	38.033	164.241	268.000
7 50 0	256.886	N 34 11.5	W 115 34.6	38.280	164.886	268.000
7 55 0	257.537	N 34 4.3	W 116 16.0	38.516	165.537	268.000
8 0 0	258.192	N 33 57.5	W 116 57.4	38.740	166.192	268.000

There is one aspect of the flight planning that will be directly applicable to the Spacelab operations; namely, the time sharing of a particular flight by two or more experiments that wish to observe different astronomical objects. The ASO flight planners and mission managers have had much experience in determining how to fit diverse observational objects and objectives into a single flight. For example, the flight plan shown is just a start. Iterations will occur between the flight planners and the P.I.'s to make the flight as productive as possible by observing appropriate objects on the eastbound leg or on a short north-south leg at the eastern end. The mission manager will assure that each experiment obtains its fair share of observing time throughout the whole mission and, in the case of conflicting requirements, will decide which experiment receives priority for a particular flight (if the experimenters themselves cannot resolve the conflict).

Not too much difficulty is anticipated in satisfying the experimenters' requests for this mission. Experiments E 1 and US 1 will not operate simultaneously since they have to share on a time basis the 30 cm open port telescope. Moreover, some of the primary objects for US 1 and US 2 are the same; namely, Venus and the Sun. Experiment US 2 has so many objects or regions available for study that it will probably have a suitable target within its field of view when E 1 is operating. Experiment US 1 does need at least one daytime flight to obtain calibration data from the Sun. That flight, which will also allow US 2 to obtain the near-UV solar spectrum, can be conducted during the unconstrained period.

The astronomical flight paths are, in general, satisfactory for the two OH airglow experiments, E 3 and US 3. Since the OH airglow clouds seem to have more structure parallel to the Earth's magnetic field than perpendicular to it, the east to west astronomical flights will allow the OH airglow cloud structure to be observed in a N-S direction. The OH airglow experiments do desire at least one flight in the N-S direction to look for latitude effects. The experiments for the far-IR background emissions, E 2 and US 4, have no particular requirements other than altitude profiles on one or two flights. Those two special requirements of the non-astronomical experiments can be combined in a couple of flights during the unconstrained period.

All of the flights will be flown from Moffett Field, California, over the western part of the United States at maximum operating altitudes of 35,000 ft. to 41,000 ft. (except for the few instances when an altitude profile is desired). Flights will be possible only over land because the 30 cm open port telescope will block the left over-wing emergency escape door. On over-water flights, the over-wing doors are the primary escape routes for an emergency landing in the water, and there must be one door available on each side so that the life rafts can be launched on the lee side of the aircraft. For a nominal six-hour flight, the operating range of the CV-990 will be between 95° and 122° west longitude, from Nebraska and Kansas to the west coast. The westward extent of flights in some latitudes will be limited by restricted flying areas in southern California and Nevada and in western Utah. Two of E 1's objects have such a southerly declination that part of the flight route will be over Mexico; prior approval of that country to overfly its territory will be needed. Since those objects are low in priority for the E 1 experiment, that situation may not arise.

Logistics

Hot meals for the constrained personnel will be delivered to the airplane from the Ames cafeteria twice each day by cafeteria personnel. Box lunches will be delivered once each day by ASO personnel.

The telephones and the special video-audio system will be removed each day before flight and will be stored in the hangar. All facilities, such as 60-Hz electrical power, water, and compressed air will be supplied from nearby sources.

Large equipment items, such as the lift-van living quarters, air conditioner, and 400-Hz power unit will be stored in the ground support equipment building during the flights and moved into position around the aircraft between flights.

Supplies needed for the experiments, such as dry ice, gaseous and liquid nitrogen, and liquid helium, will be brought from the hangar to the airplane.

Refueling of the aircraft will be performed at the simulation site on the hangar apron. All constrained personnel will remain on board for this activity.

Mission Operations

The overall mission is considered to encompass the entire period from the planning stages through completion of all science flights and the subsequent debriefing sessions. This section will discuss briefly the various activities involved in experiment preparation, experiment operator training, and the constrained period.

Experiment Operator Training. - Proper training of the experiment operators is the prime responsibility of the investigators. Each investigator will be required to develop and submit to ASO and ESRO a training plan that outlines the various tasks the E.O. will be expected to perform and the training planned for each case. The deadline for submission of the plans is given in Table I. In general, each E.O. would be expected to perform the following tasks competently for all experiments under his purview:

- Perform system tests
- Remove and install experiment components
- Operate equipment to obtain scientific data
- Maintain and repair equipment
- Process data and perform preliminary analysis

Simulation Period

Personnel Functions and Interfaces

The ASO mission manager will be the director of all activities. All contacts with the flight crew during flight will be made by the mission manager; hence, all requests by the experiment operators for changes in flight plan, special flight conditions, or the like must be transmitted through the mission manager. The final responsibility for the flight plans and flight parameters lies jointly with the ASO mission manager and the command pilot: the mission manager in respect to fulfillment of mission objectives and the command pilot in regard to aircraft operations and safety.

Experiment Operation and Maintenance

The experiment operators, in conjunction with the investigators through the telephone communications link, have complete responsibility for operation and maintenance of the experiments. No direct assistance from non-confined personnel will be permitted in the operation and maintenance of the experiments.

Daily Debriefings and Flight Planning

Debriefings will be initiated daily by the mission manager with the mission coordination center. All confined personnel will participate. The debriefings will cover problems encountered during the previous flight, quality of data, and plans for the next flight.

Mission Debriefings

At the end of the simulation period, and again at the end of the research flights under unconstrained operating conditions, a debriefing will be held involving all personnel associated with the management and conduct of the mission (exclusive of aircraft flight and maintenance personnel). The purpose of the debriefings is to review the entire mission, particularly the simulation period, with the intent of providing as much insight as possible into the experiences of the mission manager, the experiment operators, and the investigators, and their reactions to the overall ASSESS mission. To obtain a permanent record, the debriefings will be tape-recorded.

Support Operations

Insofar as possible, the support-operations plan will follow the procedures normally used in the ongoing CV-990 research program. Overall direction will be provided by the ASO mission manager. He will initiate the requests for aircraft services and flight-crew support. For this simulation mission, the special support activities related to the constrained nature of the mission, the life-support function, and the round-the-clock schedule will be planned in cooperation with the mission manager and representatives of the various support groups. The Aircraft Services and Aircraft Inspection Branches will be requested to service, maintain, and inspect the aircraft on a 24-hour-a-day basis.

Support activities of the Ames Flight Operations Branch will consist of their normal functions, adjusted to the time schedule of the simulation mission. The Aircraft Operations Office will normally be in radio contact with the aircraft while in flight and within radio range. The duty officer will monitor local weather conditions, will relay messages, will advise the ground crew of expected landing time, and will call to the office (for direct communication) any person requested by the flight crew. Aircraft commanders and co-pilots will be assigned to the research mission by the Flight Operations Branch. The aircraft commander will participate actively in the operations planning.

Support for aircraft navigation and flight planning will be provided by the ASO, using normal procedures. The requirements for each flight will be determined by the mission manager after consultation with the investigators and experiment operators. ASO flight planners will prepare specific flight plans as required by the Flight Operation Branch.

Support to set up, operate, and monitor the air conditioner, 400-Hz power unit, and living quarters, as well as to service the aircraft water system and sanitary facilities, will be provided by the Aircraft Services Branch.

ASO ASSESS personnel will make the necessary arrangements for food supply during the mission, for other supplies needed by the experiment operators, and for items related to ASSESS observations.

Safety

Flight safety is of prime importance, and normal precautions for the protection of personnel and equipment are well established. Safety requirements applicable to experiment design are given in the CV-990 Experimenters' Handbook.

The Aircraft Inspection Branch will inspect the experiment installations as well as the aircraft prior to every flight to ensure that all routine inspections and parts replacements are made on a timely basis and that any identifiable safety concern gets proper attention. They will have the authority to suspend operations if unsafe conditions are not corrected. The Airworthiness Assurance Office will oversee all designs and operational plans as they progress toward actual installation and operation. They specifically will investigate, in depth, any unique new design, including the stress analysis.

A detailed review will be presented by the mission manager to the Airworthiness and Flight Safety Review Board (AFSRB) prior to the ASSESS Mission, covering thoroughly all new designs, operational plans, contingency considerations and any other facets associated with safety.

The Chairman of the AFSRB will issue approval of the aircraft mission before implementation.

During the mission, a ground crewman will be on duty continuously when the airplane is on the ground to monitor the air conditioning unit and aircraft electrical power, and to maintain general surveillance of the area. He will have access to the aircraft cabin, and will make periodic safety inspections during sleeping periods. This crewman will also be in charge of the mobile lift-van and living quarters.

Documentation

The same documentation procedures will be used for the ASSESS mission as are normally followed by the ASO. The aircraft work order calling for installation of the experiments will be issued by the ASO mission manager and will serve three functions. It will be used to notify the AFSRB for review and approval of the safety and airworthiness of the experiments. It will be used to authorize fabrication of the attachment hardware. It will serve to notify the Aircraft Inspection Branch for inspection and approval of the final installations.

Prior to the flight period, the ASO mission manager will initiate a flight request for the entire flight series. This authorizing document will be circulated to those groups concerned with flight operations.

ASSESS OBSERVATION PLAN

Observation Requirements

Requirements for observational data cover all aspects of the mission. The following outline lists the various items that will be documented for study.

- Mission Management and Planning
- Experiment Factors
  - Measurement Objectives
  - Experimental Approach
  - Experiment Design, Including Special Features for Minimizing Operating Requirements
  - Construction Components
    - Off-the-Shelf
    - Custom-Built
    - Experimenter-Built
  - Testing Effort and Types of Tests
    - Laboratory
    - Flight
  - Cost, Size, Weight, Power Requirements

- Payload Integration
- Background of Experiment Operators
  - Education
  - Experience
    - Ground-based Research
    - Flight Research
- Training of Experiment Operators
  - Theory
  - Experiment Construction and Operation
  - Hands-on Training
    - Laboratory
    - Flight
  - Method of Establishing Training Criteria
- Performance of Experiment Operators
  - Effectiveness in Obtaining Useful Scientific Data
  - Capability in Operating, Maintaining, and Repairing Experiments
- Experiment Performance
  - Breakdowns
  - Repair Techniques
  - Impact on Data Acquisition and Mission Schedule
- Data Processing
  - Capability and Utilization of Experiment Data Processing Systems
  - Utilization of CV-990 Data Processing System
  - Extent of Data Analysis
    - On "Shuttle"
    - On Ground
  - Need for Real-time Data Analysis
  - Data Transmission
- Communication Requirements
- Timelines during Simulation Period
  - Mission Manager
  - Experiment Operators
- Mission Control Functions

- Impact of Operational Procedures on Spacelab-type Subsystems
- Aircraft Support Systems
- Electromagnetic Interference Problems
- Documentation Requirements

Observation Responsibilities

Primarily, each of the two experimental groups, ESRO and US, will be covered by observers representing each group. Observations during the simulation period will be handled by the US observer team.

Observational Procedures and Techniques

Observation starts during the training period of the Experiment Operators. Observers will document training procedures and techniques. Observers may use any method of documentation which they deem satisfactory and which does not interfere with the processes being observed. Tape recording and photography, in addition to taking notes, are acceptable techniques.

Observers will cover the period at Ames including any laboratory set-up and test time, installation of the equipment in the CV-990, test and check-out in the aircraft, and will accompany all flights of the aircraft during the mission. Daily debriefings and the final mission debriefing will be attended by the observers.

SSO:211-12 March 25, 1975

MEMORANDUM for Distribution

From: Louis C. Haughney
NASA/ESRO CV-990 ASSESS Mission Manager

Subject: The 1975 NASA/ESRO CV-990 ASSESS Program - Bulletin No. 1

SCHEDULE

A schedule for the installation and the flight phases is given in Enclosure 1. A detailed day-to-day schedule will be distributed later.

EXPERIMENT OPERATORS (EO's)

The NASA Experiment Operators will be:

Operator D,*
Lyndon B. Johnson Space Center

Operator C,*
University of Maryland

The assignments of the EO's to the experiments is given in Enclosure 2. The "primary" EO for each experiment is the one who has the principal responsibility for that experiment and who takes the lead role in operating it.

SHIPMENT OF EQUIPMENT

Shipments of equipment to Ames should be addressed as follows:

TRANSPORTATION OFFICER
FOR: HAUGHNEY/CV-990, BLDG 211-C
NASA AMES RESEARCH CENTER
MOFFETT FIELD, CALIFORNIA 94035
U.S.A.

*Names omitted.

EXPERIMENT READINESS REVIEW (ERR)

An Experiment Readiness Review will be conducted during the latter part of March or early part of April. It will be held separately for each experiment at a date and a location to be arranged by the Mission Manager and the individual Principal Investigator's (PI's). Haughney will take care of the NASA experiments and de Waard the ESRO experiments.

The objective of the ERR is to determine the present status of your experiment and its expected status a month from now when it is to be shipped to Ames for installation. A check list of items to be covered in the ERR is attached (Enclosure 3).

The ERR will also be a preliminary review of the EO's training; a significant part of the ERR will be devoted to the preparations being made by the PI's and the EO's for their joint efforts in the mission. Therefore, the EO's will participate in the ERR's.

Information on certain items in the ERR list must be returned to us in writing (on the enclosed forms) at the time of the ERR or by April 4, 1975, whichever is earlier. These items are:

Item VI.	Data Systems -	CV-990 ADDAS
Item VII.	Data Systems -	CV-990 Ampex CP-100 Analogue Tape Recorder
Item VIII.	Data Systems -	Aircraft Systems (Housekeeping) Data Required
Item IX.	Electrical Power Requirements	

Although you may have already supplied us with much of that information, please resubmit the data on the enclosed forms so that we can make sure that our records are up-to-date.

PERSONNEL INFORMATION

All persons who will come to Ames for the Mission are requested to complete Enclosure 4 and return it to us by April 4, 1975.

INSURANCE COVERAGE

The insurance coverage for persons on NASA-operated aircraft which could be purchased through the Airborne Science Office is no longer available. It is the responsibility of each person who flies on the

CV-990 to make his own investigation and decision related to insurance coverage. He is advised to ascertain whether the life and/or accident insurance he now carries protects him while on NASA aircraft, which are operated as public aircraft.

Louis C. Haughney

Louis C. Haughney

Enclosures:
1) Schedule for Installation and Flight Phases
2) Assignments of Experiment Operators
3) Experiment Readiness Review - Items to be Considered
4) Information on Visiting Personnel

ENCLOSURE 1
Page 1

NASA/ESRO CV-990 ASSESS MISSION
SCHEDULE

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			APR 30	MAY 1	2	3
4	5	6 INSTALLATION	7	8	9	10
11	12	13	14	15	16	17
18	19	20 PI's FLIGHTS (2 or 3) EO GROUND TRAINING	21	22	23	24
25	26 HOLIDAY	27 EO GROUND TRAINING	28 EO FLIGHT (1)	29	30	31
JUNE 1	2	3 SPACELAB SIMULATION	4 (5 Flights)	5	6	7
8	9	10 PI's FLIGHTS	11 EMI TESTS	12	13	14
15	16	17 (6 to 8)	18	19	20	21
22	23 REMOVE EXPERIMENT	24				

3/4/75

NASA/ESRO CV-990 ASSESS MISSION

ASSIGNMENTS OF EXPERIMENT OPERATORS

EXPERIMENT GROUP	RESPONSIBLE EO	
	PRIMARY	SECONDARY
Queen Mary College		C
University of Southampton	B	
University of New Mexico		A
Meudon Observatory and University of Groningen	A	B
Ames Research Center	D	C
Jet Propulsion Laboratory		D
	C	
University of Alaska		B

3/5/75

NASA/ESRO CV-990 ASSESS MISSION

EXPERIMENT READINESS REVIEW

I. Mounting and Installation

- Standard Racks
  - layout of components in each rack with individual weights and dimensions
  - calculations of total weight, center of gravity, and overturning moments

- Other Mounting Stands
  - status of design
  - status approval by ASO
  - status stress analyses (if needed)
  - status fabrication

II. Instrumentation

- Availability of individual components
  - on hand
  - to be delivered (when?)

- Testing and usage of equipment
  - schedule
    - already done
    - to be done in future
  - degree of testing
    - individual components
    - complete systems
  - circumstances of testing
    - laboratory
    - field
  - results
    - good
    - problem areas

- Back-up units
  - criteria for providing back-up units
  - list of back-up units to be provided
  - status
    - availability
    - testing and check-out

EXPERIMENT READINESS REVIEW (continued)

II. Instrumentation (con't.)

- Supporting equipment to be provided by experimenter

  - type of item
    test and calibration equipment
    tools
    spare parts
    supplies

  - expected location of such items

    ASO laboratory and shop
    airplane
      weight and volume
      need of accessibility in flight

- Supporting equipment and supplies to be provided by ASO

  - list sent yet to ASO
    specifications and usage rates
    examples -
      10 liters of liquid helium per day
      1 vacuum pump-capacity?

III. Flight Route Requirements

- List of desired observational targets

  - flight routes
  - flight times

IV. Experiment Operator (EO) Training

- Training plan

  - visits of EO's to PI's

- Evaluation Criteria

- Material ready for EO's

  - descriptions of experiment
    reference papers

EXPERIMENT READINESS REVIEW (continued)

IV. Experiment Operator (EO) Training (con't.)

- . descriptions of equipment
  - technical manuals
  - circuit diagrams
  - system block diagrams
  - critical part list
- . operational procedures
  - check list
  - sequential schedule
- . data handling
  - criteria for quick-look evaluations

– EO timeline for operating experiments

- . to be developed by responsible EO with assistance from PI
- . work done to date on this
- . final version due May 15

V. Data Systems - Integral Part of Experiment

– Functions

- . recording
- . real-time analysis
- . real-time control

– Status

- . availability of all components
  - hardware
  - software
- . testing
  - schedule
  - extent - subsystems
  - complete systems

– Interface with CV-990 systems

- . ADDAS
- . aircraft systems data

– Interface with Ames ground facilities

- . film processing
- . tape dubbing
- . tape processing
  - Ames computers

NOTE: RETURN THIS PAGE WITH REQUESTED INFORMATION TO THE MISSION MANAGER BY APRIL 4, 1975. (Use additional sheets if necessary.)

EXPERIMENT READINESS REVIEW (continued)

VI. Data Systems -CV-990 ADDAS

Input Signals to ADDAS	1	2	3	4
Name of Signal				
Type of Signal				
Analogue -				
Sampling rate				
Voltage				
Resistance				
Frequency				
Digital				
Word length				
Rate				
Synchro				
Voltage				
Location in airplane where signal originates				

NOTE: RETURN THIS PAGE WITH THE REQUESTED INFORMATION TO THE MISSION MANAGER BY APRIL 4, 1975. (Use additional sheets if necessary.)

EXPERIMENT READINESS REVIEW (continued)

VI. Data Systems - CV-990 ADDAS (con't.)

Output Signals from ADDAS	1	2	3	4
Name of Signal				
ADDAS to				
- Printer				
rate				
- TV display				
- experiment system				
voltage				
rate				
conversion & calibration formulas supplied to ADDAS?				

VII. Data Systems - CV-990's Ampex CP-100 Analogue Tape Recorder
(14 channel, 25.4 mm (1 in) tape, 190 mm/sec
(7-1/2 in/sec) $\pm$ 12.5 v p-to-p input; 1 v rms output)

	1	2	3	4
Name of Signal				
voltage				
frequency				
mode - Direct recording - FM recording				
location of signal in airplane				

NOTE: RETURN THIS PAGE WITH THE REQUESTED INFORMATION TO THE MISSION MANAGER BY APRIL 4, 1975.

EXPERIMENT READINESS REVIEW (continued)

VIII. Data Systems - Aircraft Systems (Housekeeping) Data Required

Name of Signal	To Experimenter's Systems (Give Specs)	To ADDAS Print-out (Give Rate)	TV Display
Time Code			
IRIG B			
NASA 36			
Slow code			
Time pulses (specify)			
Latitude			
Longitude			
Heading			
Roll			
Pitch			
Pressure altitude			
Radar altitude			
Static air temperature			
Drift angle			
Cabin pressure			
Ground speed			
____________			
____________			
____________			

NOTE: THIS PAGE IS TO BE FILLED OUT AND RETURNED TO

L. C. HAUGHNEY
AIRBORNE SCIENCE OFFICE, 211-12
NASA-AMES RESEARCH CENTER
MOFFETT FIELD, CA 94035
U.S.A.

BY THE TIME OF THE ERR OR BY APRIL 4, 1975, WHICHEVER IS EARLIER.

EXPERIMENT READINESS REVIEW (continued)

IX. Electrical Power Requirements

Type of Power	Current (amps) or Power (kw) Needed				
	Rack or Stand No.[1]				
	1	2	3	4	5
60 hz, 1 ϕ, 115v					
400 hz, 1 ϕ, 115v					
400 hz, 3 ϕ, 115v					

Note: [1]Give the location of the rack or stand in the airplane.

NASA/ESRO CV-990 ASSESS MISSION

INFORMATION ON VISITORS TO NASA/AMES

Please provide the following information for each person who will come to Ames for the Mission. Make additional copies if necessary. Return forms to us by April 4; send later revisions and additions as soon as possible.

NAME ______________________

INSTITUTION ______________________

ADDRESS ______________________

____

TELEPHONE ______________________

POSITION IN MISSION ______________________

CITIZENSHIP ______________________

DATES AT AMES ______________________

Person to be notified in case of emergency:

Name ______________________

Address ______________________

____

Telephone ______________________

Relationship ______________________

SSO:211-12 April 14, 1975

MEMORANDUM for Distribution

From: Louis C. Haughney
NASA/ESRO CV-990 ASSESS Mission Manager

Subject: The 1975 NASA/ESRO CV-990 ASSESS Program - Bulletin No. 2

FLOOR PLAN

A revised floor plan is attached (Enclosure 1). The revisions reflect mostly more details on the layout of the JPL/Alaska experiment.

SCHEDULE

A detailed schedule of activities during the installation and the flight phases is given in Enclosure 2.

MISSION SCIENTIST

At its meeting of March 6 and 7, the Mission Planning Group appointed Robert M. Cameron as the Mission Scientist. Cameron is the Astronomy Programs Manager in the Airborne Science Office; he is in charge of the C-141 Airborne Infrared Observatory. Edgar R. Miller of the NASA Marshall Space Flight Center will be the assistant Mission Scientist.

During the Spacelab simulation, the Mission Scientist will be the chief spokesman for the Principal Investigators (PI's). He will work very closely with the PI's to develop the daily observation plan. If any problems arise in regard to achievement of scientific objectives, the Mission Scientist will work out a solution which he will present to the Mission Manager for concurrence.

ASSESS INFORMATION DUE FROM PI'S

Because of the importance of this CV-990 mission to the Spacelab planners, quite a bit more information is needed about the experiments than is usually requested for regular ASO missions. The PI's are reminded of the "Observation Plan for NASA/ESRO ASSESS Program" that was distributed at the Experimenters' Meeting in Paris, November 20-21. The list entitled "Due Dates for ASSESS Information," from that document is reproduced here as Enclosure 3.

Particular attention is drawn to the following sets of information which are due at Ames by April 30.

1) PI's Information Packet for EO's.

   Operations manuals
   Maintenance manuals
   Schematics
   Published papers on prior results
   Background material

2) PI's Final List of Observational Objects and flight routes.

3) Lists of Tools and Spare Parts to be Supplied by PI's.

LIST OF EXPERIMENTS

A list of the experiments, the Principal Investigators (PI's), and their organizations is given in Enclosure 4.

EXPERIMENT OPERATORS (EO's)

The four Experiment Operators are:

Operator A,
Queen Mary College, London

Operator B,
University of Sussex

Operator D,
Lyndon B. Johnson Space Center

Operator C,
University of Maryland

COORDINATORS

The personnel who are coordinating the Ames Research Center's support of this mission are as follows:

1) Louis C. Haughney, Mission Manager and Flight Director
   (415) 965-5339

2) John O. Reller, Jr., Assistant Mission Manager
   (415) 956-5392

3) Carr B. Neel, ASSESS Program Manager
   (415) 965-6430

4) Curtis L. Muehl, CV-990 Facility Manager
   responsible for the Airborne Digital Data Acquisition System (ADDAS) and interfaces between experiments and CV-990 systems (electrical power, housekeeping, etc.)
   (415) 965-6431

4.1) Donald L. Wilson, CV-990 ADDAS Programmer (Informatics)
   (415) 965-5505

5) Alan L. Campbell, CV-990 Program Engineer
   responsible for the certification of the experiment equipment design, construction, and installation aboard the CV-990.
   (415) 964-6319

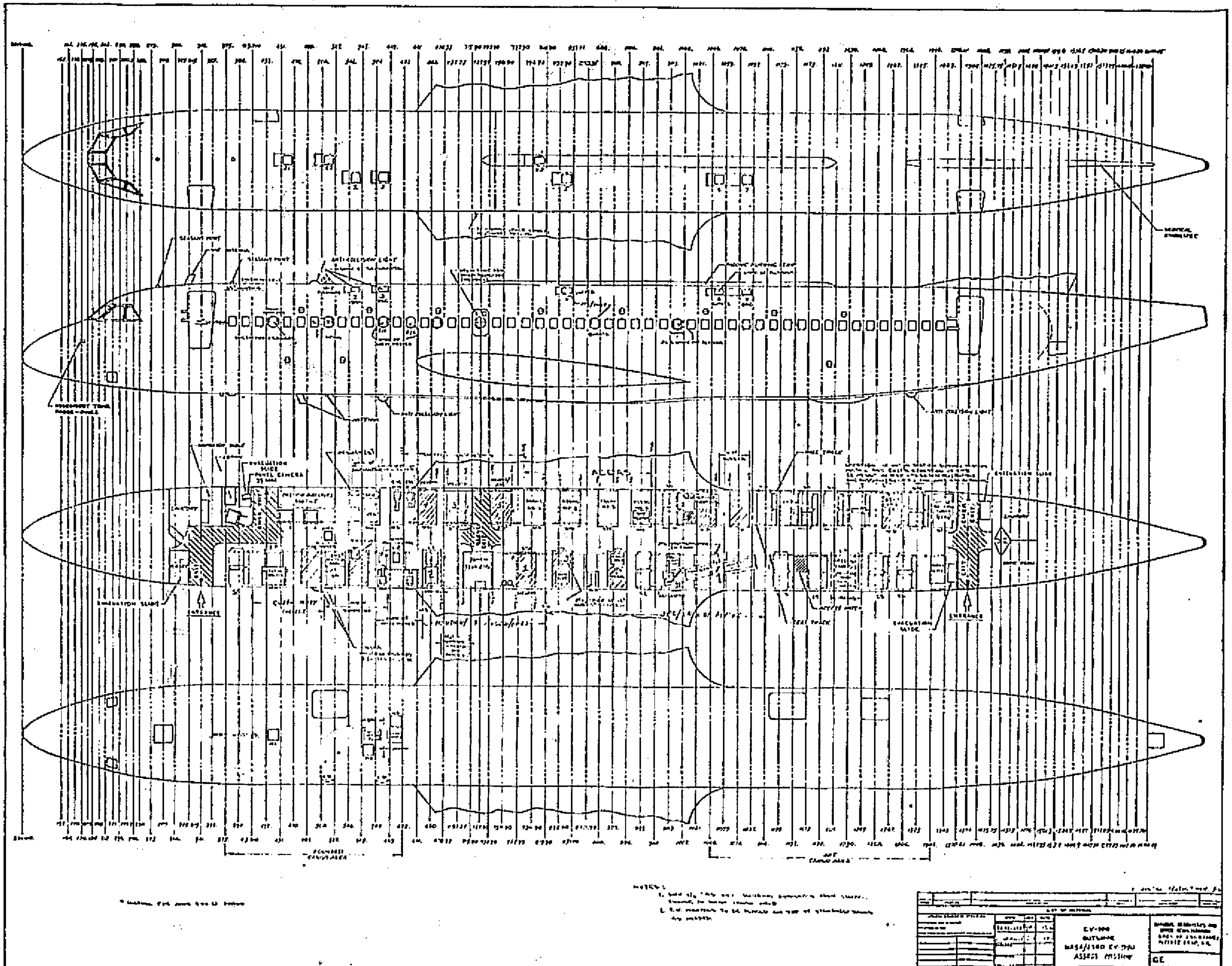
5.1) Seth S. Kurasaki, Design Engineer
   Earl O. Menefee, Design Engineer
   (415) 965-6319

Louis C. Haughney

Louis C. Haughney

Enclosures:
As stated

1) Revised Floor Plan
2) Detailed Schedule of Activities
3) Due Dates for ASSESS Information
4) Experiments for CV-990 NASA/ESRO ASSESS Mission



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NASA/ESRO CV-990 ASSESS MISSION

SCHEDULE

April 15 (Tue) Thru April 28 (Mon)	Shipment of equipment to Ames.
April 30 (Wed) Thru May 15 (Thur)	Installation and check-out of experiments in airplane. A short meeting will be held at 1300 each day to review the daily status of the mission and to pass on information to the experimenters. The meetings will be held in the ASO Experimenters' Laboratory from April 30 to May 15. They will last about 15 minutes; everyone will be standing up. Because of the many activities to be coordinated, it is important that everyone attend these meetings.
May 16 (Fri)	Airplane weight, balance, and preflight maintenance. Airplane not available to experimenters today. Any items and supplies installed on or removed from the CV-990 after this date must be recorded on the weight and balance sheet posted at the airplane's main door.
May 19 (Mon)	Aircraft maintenance and pilot proficiency flights. Aircraft not available to experimenters today. Experimenters' Meeting. Purpose: Plans for final EO ground training and for flights. Time and Location: 1300 PDT - Monday, May 19 ASO Conference Room Bldg. 211-Rm 241

SCHEDULE
(con't)

May 20 (Tue)	(1)	<u>Pilot proficiency flight.</u> Aircraft will be available after the flight. Times will be announced at meeting of previous day.
	(2)	<u>Aircraft safety indoctrination.</u> This training is mandatory for all who fly on the CV-990. <u>Time</u>: To be announced. <u>Location</u>: ASO Conference Room and CV-990 airplane.
May 20 (Tue) Thru May 30 (Fri)	(1)	<u>Ground training of EO</u>'s. Airplane will be parked out on the ramp in the corner so that the night sky can be observed.
	(2)	<u>PI Flights (two or three)</u>. Nighttime data and check-out flights. (EO's do not participate. Dates to be announced.)
	(3)	<u>EO Check Flight (1)</u>. Nighttime (probably May 28 or 29).
		NOTE: Monday, May 26 is a holiday. (Memorial Day)
May 30 (Fri)		Experimenters' Meeting. <u>Purpose</u>: Flight Readiness Review for Spacelab simulation and final briefing. <u>Time</u>: 1100 PDT (tentative-depends upon flight schedule of previous night). <u>Location</u>: ASO Conference Room.
June 2 (Mon) Thru June 6 (Fri)		Spacelab simulation. Five flights in five nights.
June 7 (Sat)		Debriefing for Spacelab simulation (time and location to be determined).

SCHEDULE
(con't)

June 9 (Mon) Thru June 20 (Fri)	Data flights for PI's and EO's. 5-7 nighttime flights 1 daytime flight EMI testing.
June 24 (Tue)	Debriefing for NASA and ESRO management. Remove experiments from aircraft.

Due Dates for ASSESS Information

Due on Arrival of Investigators and EO's at Ames - April 30, 1975

ITEM	REFERENCES (To Observation Plan)
Experiment Summary	Section 2.1 Sample 1
Investigator's Background	Section 2.1
Investigator's Publication List	Section 2.1
Information on Investigators Organization	Section 2.2
Experiment Description	Section 3.3
Experiment Development History	Section 3.4 Sample 2
Basic Block Diagram	Section 3.5 Sample 3
Experiment Equipment Characteristics	Section 3.6 Sample 4 & 5 (during installation)
Normal Planned Operation	Section 4.3
Fallback Operation	Section 4.3
Training Program Plans	Section 4.4
Training Evaluation Criteria	Section 4.4
~~Background of Experiment Operators~~	~~Section 4.4~~ (Available)
Systems Displays and Centralized Controls	Section 3.5 Sample 6 (during installation)
Sketch of Optics	Section 3.6 Sample 7
Data Handling Summary	Section 3.7 Sample 8 (ADDAS covered in Experimenters' Bulletin #1. Need data on your recorders.)
Modifications for this Mission	Section 3.7 Sample 9
Home Base Preparation Plan and Performance	Section 4.1 Sample 10
Home Base Testing	Section 4.2 Sample 11
Test Procedures	Section 4.2 Sample 12
~~Experiment Readiness Review Documentation for ERR before shipment~~	~~Section 5. Sample 13~~ (covered in Experimenters' Bulletin #1)

Enclosure 4
Page 1

List of Experiments for CV-990 NASA/ESRO ASSESS Mission

INSTRUMENTATION	EXPERIMENTERS*	MEASUREMENT
1. 30-cm Cassegrain Telescope with 4-channel IR Photometer. Cooled Ge Bolometer	Observatoire de Paris CNRS-Verrieres University of Groningen	High-Resolution mapping of Dark clouds and HII regions. Wavelengths: 17-20μm, 30-38μm 70-95μm, and 114-196μm
2. Polarizing Interferometer. Cooled Ge Bolometer.	Queen Mary College University of London	IR Emission Spectrum of upper atmosphere. Wavelengths: 40μm-2mm
3. Imaging Isocon TV Camera	University of Southampton	Observation of OH airglow clouds. Wavelengths: 650-950nm
4. 30-cm Cassegrain Telescope (Meudon) with variable Filter-wedge spectrometer. Cooled Ga:Ge Detector.	NASA/Ames Research Center	Near IR Spectra of Venus and Late Type stars. Wavelengths: 3-6μm
5. A. 12.5-cm Ebert-Fastie UV Spectrometer B. 1 m Ebert-Fastie Spectrometer C. Tunable Acousto-Optical Filter Spectrometers (2)	NASA/JPL University of Alaska	UV measurements of atmospheric transparency, solar flux, planetary atmospheres, and interstellar molecules. Wavelengths: 2900-4000 Å 4500-8000 Å

*Names omitted.

List of Experiments for CV-990 NASA/ESRO ASSESS Mission

INSTRUMENTATION	EXPERIMENTERS*	MEASUREMENT
6. A. 35 mm Camera with IR image intensifier. B. 16 mm Camera for time-lapse photography. C. IR Photometer	University of New Mexico	Photography of IR OH airglow clouds. Wavelengths: 6500-9000 Å
7. IR Filter Wheel Radiometer; FOV = 2° (Zenith-to-Nadir Scan Angle)	NOAA-APCL	Four filter bands: 1) 15.0μm CO_2 band - static air temperature. 2) 5.0 to 33.0 μm - total IR radiation. 3) 8.0 to 13.0 μm - surface temperature. 4) 19.0 to 35.0 μm - humidity.

*Names omitted.